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# THE CHEMICAL NEWS.

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## THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ.

### I. INTRODUCTION.

THE element uranium although classed with chromium, molybdenum, and tungsten in the periodic system is peculiar in that it resembles members of other groups of elements as well. Beyond the electrolytic analysis (Smith, *Am. Chem. Journ.*, 1879, i., 329), the conductivity of the aqueous solutions of its salts (Dittrich, *Zeit. Phys. Chem.*, 1899, xxix., 449), the effect of light on the potential of uranous uranyl solutions using platinum electrodes (Baur, *Zeit. Phys. Chem.*, 1908, lxiii., 683, and Titlestad, *Zeit. Phys. Chem.*, 1910, lxxii., 257) a similar investigation by Luther and Michie (*Zeit. Elektrochem.*, 1908, xiv., 367), very little is found in the literature concerning the electro-chemistry of uranium. McCoy and Bunzel have used potential measurements for determining the rate of oxidation of uranous solutions (*Journ. Am. Chem. Soc.*, 1909, xxxi., 367).

In the paper here presented are contained accounts of experiments on the electrolysis of various uranium compounds. These experiments were made in order to ascertain the electrolytic behaviour of different uranium compounds in aqueous solutions, non-aqueous solutions, and in fusions. The hope at first was that a method of preparing uranium electrolytically might be found. While metallic uranium was not thus prepared in the pure state, quite a number of compounds of uranium were formed electrolytically. The conditions of the formation of these compounds have been detailed, and their single potentials have been ascertained whenever a sufficient amount of pure material was formed in the experiment.

The difficulties involved in the electrolysis of uranium compounds are many. The metal does not deposit as such from aqueous solutions of either uranyl or uranous salts, but it is deposited as a poorly adhering oxide of variable composition, most probably in the form of the uranyl radicle, $UO_2$, or its hydrates. Prepared in other ways, such as the reduction with metallic potassium (Peligot, *Ann. Chim. Phys.*, 1842, [3], v., 1) or metallic sodium (Zimmermann, *Liebig's Ann.*, 1882, ccxvi., 14), by electrolysis of fused double sodium uranous chloride (Moissan, *Comptes Rendus*, 1896, cxxii., 1088), reduction in the electric furnace with carbon (Moissan, *Comptes Rendus*, 1893, cxvi., 369), and the reduction with aluminium (Aloy, *Bull. Soc. Chim.*, 1911, [3], xxv., 153), the metal has never been obtained absolutely pure. It is a metal that burns at a low temperature (170°), reacts with cold water, and combines with nitrogen, carbon, and oxygen so readily that its preparation in absolutely pure form is well nigh impossible.

The uranous salt solutions are easily oxidised, and for this reason an attempt to electrolyse a uranous solution always results in the formation of uranyl salts around the anode and a deposition of oxide on the cathode. It may also be possible that the reaction of the metal with water is the explanation of the deposit of the oxide at the cathode. Whatever the explanation may be it has thus far been experimentally impossible to plate pure metallic uranium, especially from aqueous solutions.

Muthmann and Fraunberger measured the single potential of metallic uranium against a normal solution of potassium chloride, and reported a value of 0·19 volt (*Akad. Wiss. München*, 1904, xxxiv., 201). No analyses indicating the purity of the metal used are given. My own measurements with a sample containing 91·49 per cent metallic uranium in normal potassium chloride solution gave a single potential of −0·099 volt, which is substantially the same as that developed by the same sample of metal immersed in uranyl nitrate solutions containing 14·3 grms. per litre. It is possible that Muthmann and Fraunberger attach a different meaning to the ± sign before the figure which they give. On the other hand, the uranium they had was undoubtedly of a different state of purity to my own which was contaminated with ferric oxide. Neither result can, of course, be considered as final since the metal used was not pure.

### II. EXPERIMENTAL.

(NOTE.—In all the electrolytic experiments the potential impressed is given in volts and the current density is stated in ampères per square decimetre).

#### 1. *Pyridine as a Solvent for Uranyl Salts.*

Tests upon the solubility of uranyl nitrate, chloride, acetate, sulphate, and oxalate were made by treating small portions of the different salts with pyridine. Uranyl nitrate was found to be the most easily dissolved, though uranyl chloride and acetate are also appreciably soluble. They are more soluble in cold pyridine than in hot. When heated in a water-bath at the boiling temperature a flocculent yellow precipitate was thrown down in each case. Uranyl sulphate and uranyl oxalate were only slightly soluble in pyridine. The yellow precipitates

* A portion of the thesis submitted to the Graduate School of the University of Wisconsin in partial fulfilment of the requirement for the degree of Doctor of Philosophy. From the *Journal of Physical Chemistry*, xxiii., No. 8.

brown down on heating the solutions were not dissolved when the solution cooled, and could not be brought into solution again in the pyridine.

2. *Electrolysis of Uranyl Salts in Pyridine Solution.*

Many electrolytes are known to yield conducting solutions when dissolved in pyridine, and metals have been deposited electrolytically from such solutions (*Journ. Phys. Chem.*, 1899, iii., 602), which could not be deposited from aqueous solutions. A saturated solution of uranyl nitrate in pyridine was tried in hopes that metallic uranium might be deposited from this solution electrolytically. The uranyl nitrate used was Merck's "highest purity," while the pyridine used was Baker's pure pyridine. In the preliminary trials the pyridine was not anhydrous. The solution was not a very good conductor. A pressure of 14 volts was required to give any perceptible reading on the milliammeter used. When the voltage was increased to 30 a current density of 0·31 amp. was obtained. The solution became very dark, due to the carbonisation of the pyridine. After allowing the current to run for three hours the cathode was covered unevenly with a black deposit. The side facing the anode naturally was covered thicker than the other. The excess of pyridine was washed from the deposit with petroleum ether, and after drying in the air examined for uranium. The deposit resembled carbon, but on dissolving the black material in nitric acid it gave a straw-coloured solution which, when tested qualitatively, showed that uranium was present in considerable quantity.

A fresh solution of uranyl nitrate in pyridine was prepared and electrolysed with a voltage of 30 and current density of 0·311 amp. In this trial the anode was surrounded by a muslin bag acting as a diaphragm. This arrangement did not prevent the blackening of the pyridine. After three hours the cathode was removed and examined. A black deposit was spread unevenly over the cathode and had a striated appearance. It was washed with gasoline and then allowed to dry in the air. When dry it had a reddish colour like partially oxidised copper, and was loosely adherent. An attempt was made to measure the single potential of the plated material against a uranyl nitrate solution, but as soon as the electrode was dipped into the electrolyte a portion of the coat fell off exposing platinum, so that a reliable measurement was not obtained. Diaphragms of other materials were tried, including a Schleicher and Schull extraction thimble, a bag made of filter-paper, and also a bag made of bolting cloth, but nothing was found that would prevent the spread of the carbon formed around the anode, so that the product on the cathode would not be contaminated. A smoother adhering deposit was obtained by revolving the beaker during electrolysing, but no clear metallic deposit could be obtained nor was the deposit large enough to analyse. The pyridine also charred when uranyl acetate and uranyl chlorides were used as electrolytes, a positive proof that the nitrate radicle, $UO_3$, was not responsible for the charring of the pyridine. Although uranyl sulphate and uranyl oxalate were both slightly soluble in pyridine neither prevented the charring of the solution when electrolysed. The anode in both cases became very dark brown, but no uranium deposit could be found on the cathode. The voltage used was 100 in each case. The current was not recorded in this case because of a faulty ammeter.

No satisfactory deposit of uranium can be obtained from the solutions of the uranyl salts in pyridine because of (1) the charring of the solvent, (2) the failure of the uranyl radicle to reduce, and (3) the contamination of the deposit by the charred pyridine.

3. *Electrolysis of an Ether Solution of Uranyl Nitrate.*

One grm. of uranyl nitrate containing its water of crystallisation was dissolved in 50 cc. of anhydrous ether, and placed in a closed cell connected with a reflux condenser. It was electrolysed under a pressure of 100 volts, and gave a current density of 0·12 amp. at the beginning. The side of the cathode facing the anode became covered with a silvery-white deposit. After electrolysing for six hours the cathode was removed and the deposit washed with fresh ether. It dried quickly in the air leaving a deposit, white in appearance, but slightly tinged with yellow. This deposit did not adhere well to the electrode and was easily brushed off with the finger. It could not be washed off with water, but was readily removed with nitric acid. The nitric acid solution gave a qualitative test for uranium.

Further tests made in the same solution under similar conditions and also made with a rotating cathode gave in each case deposits silvery-white in appearance at first, but when allowed to stand in a calcium chloride desiccator for a while they became yellow. Freshly dissolved uranyl nitrate containing its water of crystallisation always conducted better than at first. After running for a short time the current gradually fell off, finally becoming practically zero. The conductivity of the ether solution therefore appears to be a function of the amount of water present. After the electrolysis has decomposed the water present the conductivity practically ceases. Solutions made with ether that was not anhydrous were better conducting media than when anhydrous ether was used, but eventually they behaved in the same way. Because of the poor conductivity of ether solutions the use of ether as a solvent was abandoned. The nature of the deposit formed was not ascertained. It could only be obtained in small quantities insufficient for analysis.

4. *Electrolysis of Ethyl Acetate Solution of Uranyl Nitrate.*

A solution of uranyl nitrate in ethyl acetate was prepared. No attempt was made to get perfectly anhydrous material, for the uranyl nitrate carried water of crystallisation. The solution contained 1 grm. of uranyl nitrate in 50 cc. It was electrolysed with a voltage of 95, and at this pressure gave a poorly conducting solution. The current density was 0·2 amp. A deposit began to form on the side of the cathode facing the anode immediately, but the opposite side remained clear. The beaker was rotated throughout the run, but an even deposit was not obtained. The cathode was removed after two hours, washed with fresh ethyl acetate, and dried in a desiccator over calcium chloride. The deposit was dark when first dried, but became yellow while standing overnight in the desiccator. The weight of the deposit was only 30 mgrms. It was removed from the electrode by 1 drop of concentrated nitric acid, and washed back into the solution with ethyl acetate. The addition of the 1 drop of nitric acid increased the conductivity of the solution. The latter was electrolysed with a voltage of 50, and a current density of 0·21 amp. A flocculent yellow deposit collected around the cathode but did not adhere. It sloughed off at once and piled up under the cathode when stationary. This deposit was not analysed, but to all appearances was the yellow oxide of uranium, $UO_3$. No trace of uranium could be found on the cathode when removed and washed with fresh ethyl acetate.

Another trial with a freshly prepared solution of uranyl nitrate in ethyl acetate containing no free nitric acid was made. The voltage used was 40 and the current density 0·100 amp. The electrolysis was made without rotation of the solution, and was allowed to continue for twelve hours. A yellow deposit was formed on the side of the cathode facing the anode, but the other side remained clear. The deposit was spongy and poorly adherent, a part falling off during the electrolysis. The deposit was washed with fresh ethyl acetate, and allowed to stand in a calcium chloride desiccator overnight. When dry the deposit weighed only 4·7 mgrms. and was easily brushed off. It appeared to be principally the yellow oxide of uranium mixed with a small bit of a black oxide.

Because of the poor conductivity of the solution and the small amount of deposit obtained no analysis of the pro-

luct was made, and no potential reading could be taken because the electrode was not covered entirely with deposit. The use of the ethyl acetate solution for electrolysis had to be abandoned.

5. *Electrolysis of an Amyl Alcohol Solution of Uranyl Nitrate.*

A solution of uranyl nitrate in amyl alcohol was prepared. The solution contained 1 grm. of crystallised uranyl nitrate in 50 cc. of the alcohol. No attempt was made to prepare anhydrous alcohol because of the water contained in the uranyl nitrate. The solution was poorly conducting, giving a current density of 0·19 amp. under a pressure of 130 volts. A bronze-like deposit, very smooth, was formed on both sides of the cathode. The deposit was quite thin and iridescent. The potential of this deposit was taken with a solution of uranyl nitrate containing 12·3190 grms. of anhydrous uranyl nitrate per litre. The single potential was found to be −0·2691 volt. Attempts to get a sufficient quantity of this bronze-like deposit for analysis were futile. In each case only a few mgrms. were deposited after electrolysing under the conditions mentioned above for periods of twelve hours and longer.

On adding 5 cc. of water to the amyl alcohol solution the conductivity increased. The solution became warm and a heavier deposit was obtained. The maximum current density reached under a pressure of 130 volts was 0·65 amp. The deposit formed under these conditions was black and poorly adherent. It was washed with ether and dried over calcium chloride to constant weight, and analysed for its uranium content. It contained 73·72 per cent of uranium, and gave a single potential against the uranyl nitrate solution of −0·483 volt.

Sample No. 2, deposited under conditions exactly as the above, gave on analysis 71·36 per cent of uranium.

It is evident that the electrolysis of uranyl nitrate in amyl alcohol solution does not give metallic uranium, and when water is present the composition of the deposit approaches that obtained from aqueous solutions.

6. *Electrolysis of Double Potassium Uranyl Cyanide.*

Moissan states that the cyanides of uranium have not been prepared ("Traité de Chimie Minerale," iv., 885). When a potassium cyanide solution is added to an aqueous solution of uranium tetrachloride, hydrated uranium oxide is precipitated with evolution of hydrocyanic acid gas. Aloy (*Ann. Chim. Phys.*, 1901, [7], xxiv., 412) prepared uranyl potassium cyanide by precipitating the uranium from uranyl nitrate with potassium cyanide and dissolving the precipitate first formed in an excess of potassium cyanide and then concentrating the solution.

To a solution of Merck's pure uranyl nitrate potassium cyanide solution was added slowly. A canary-yellow gelatinous precipitate formed at once, and an odour of hydrocyanic acid was noticed. The precipitate was filtered off and washed with cold water to remove the potassium nitrate. The precipitate was removed from the filter and treated with an excess of potassium cyanide. Some of the precipitate would not dissolve in the potassium cyanide solution, but was soluble in a solution of hydrocyanic acid.

The hydrocyanic acid was prepared by treating silver nitrate solution with potassium cyanide solution in the molecular ratio required to just precipitate all the silver as silver cyanide. This was filtered off and washed with water until free from any slight excess of silver nitrate and then stirred up thoroughly, while kept ice cold, with hydrochloric acid, keeping the hydrochloric acid just short of the amount needed to convert all of the silver cyanide to silver chloride. The filtered solution was free from silver, and left no residue when evaporated. This solution was used to dissolve the precipitate that remained insoluble in the excess of potassium cyanide. It dissolved completely in the hydrocyanic acid solution. This portion, insoluble in potassium cyanide but soluble in hydrocyanic acid, was in all probability potassium uranate.

Electrolysis of the double potassium uranyl cyanide solution under a pressure of 4 volts and a current density of 0·62 amp. gave deposits of yellow uranic hydroxide in neutral solution and evolved cyanogen. The deposit sloughed off and settled to the bottom of the cell. The solution became alkaline toward phenolphthalein during the action due to the loss of the volatile acid.

Solutions made acid with hydrocyanic acid likewise evolved cyanogen and deposited yellow uranic oxide on the cathode. This deposit immediately sloughed off, but dissolved again as long as there was free acid in the solution.

By the use of a roughened platinum electrode and a higher current density a better adhering product was obtained, which was black and uniformly deposited on the cathode.

The weight of the deposit was 67 mgrms., and was obtained by electrolysing the acid solution for three hours under a pressure of 8 volts and a current density of 0·2 amp. The deposit, when washed with alcohol and ether, gave a single potential of −0·461 volt against the standard uranyl nitrate solution.

The deposition of metallic uranium does not take place in aqueous potassium uranyl cyanide solution either neutral or acid with hydrocyanic acid. With low current density the deposit is uranic oxide. Higher current density changes this to a black hydrated oxide. The composition of the deposit was not ascertained, since it was only obtained in quantities too small for analysis.

7. *Electrolysis of a Solution of Double Sodium Uranyl Oxalate.*

The electrolysis was made with an aqueous solution of double sodium uranyl oxalate prepared by dissolving 5 grms. of uranium oxalate (E. de Haen, labelled "chemically pure") in 75 cc. of water, and adding sodium oxalate (Squibb's "C.P. reagent") to the solution in the molecular proportion required to form the double salt. It was electrolysed with a pressure of 5 volts and a current density of 1·55 amp. There was formed immediately a black deposit, poorly adherent, which sloughed off, leaving the cathode exposed in spots. The usual yellow deposit that first forms on electrolysing aqueous solutions of uranyl salts did not appear. The weight of the deposit after electrolysing for three hours was 40 mgrms. The greater portion of the uranium had been precipitated during the electrolysis and remained undissolved in the solution.

From this almost depleted solution with a pressure of 7 volts and current density of 0·77 amp. a deposit was obtained which adhered well, was smooth in appearance, and showed no trace of the yellow oxide. It weighed 30 mgrms., and gave a single potential of −0·381 volt against the standard solution of uranyl nitrate.

The same solution was made acid with oxalic acid and electrolysed with a pressure of 10 volts and a current density of 7·75 amp. The solution became warm during the electrolysis. The evolution of gas from the cathode prevented the formation of a smooth deposit. After three hours the deposit formed weighed only 13 mgrms. No trustworthy single potential could be obtained of this material since the platinum was exposed in spots.

Plating from an aqueous solution of double uranyl sodium oxalate does not deposit metallic uranium. The deposit was not obtained in sufficient quantity for analysis, but its single potential was ascertained.

8. *The Electrolysis of an Aqueous Solution of Double Potassium Uranyl Fluoride.*

Double potassium uranyl fluoride has been prepared by Baker (*Journ. Chem. Soc.*, 1879, xxxv., 760), and also by Smithells (*Journ. Chem. Soc.*, 1885, xliii., 123), by precipitating the uranium from uranyl nitrate with potassium fluoride, and also by the action of hydrofluoric acid on

potassium uranate, or by mixing potassium fluoride and uranyl fluoride in molecular proportions required for the formula $2KF.UO_2F_2$. The double salt of uranium tetrafluoride with potassium fluoride has not been prepared.

Attempts to prepare the latter salt were made by fusing uranium tetrafluoride with the required amount of potassium fluoride to give the salt $2KF.UF_4$ corresponding to the analogous double potassium uranium chloride. This was unsuccessful because uranium tetrafluoride is converted into an oxide with loss of fluoride on heating. The residue left was only partly soluble in water, but completely dissolved in hydrofluoric acid. The yellow solution thus prepared was used for the electrolysis after evaporating to dryness to remove the excess hydrofluoric acid and redissolving in water.

It was electrolysed in a hard rubber beaker under a pressure of 6 volts and a current density of 2·32 amp. for one hour. On removing the cathode and washing with water no deposit could be seen. The cathode was treated with concentrated nitric acid, and the washings were tested for uranium with negative results. On heating the electrode the platinum first turned a yellow colour, and on stronger heating became green. The coat now dissolved in nitric acid and gave a splendid test for uranium.

A second experiment made with the same solution gave a deposit silvery-white with just a tinge of blue-green. Its weight was uncertain because the glass stem of the electrode had been attacked by hydrofluoric acid. The deposit was obtained by electrolysing the solution for two and one-half hours with a voltage of 7 and a current density of 3 9 amp. The single potential of the plated material was measured against the standard uranyl nitrate solution and gave −0·389 volt. Under the same conditions the same general deposit could always be obtained, and the deposits gave nearly the same potential as recorded.

The conditions were varied slightly, and a different deposit was found. In this experiment under a voltage of 4 and a current density of 2·54 amp. a white deposit seems to form first, but is covered with a black oxide. The deposition was carried on in the same solution as before, except that it had been acidified with hydrofluoric acid. With a higher voltage 8 volts and a current density of 14 amp., a heavier deposit of the black oxide is formed. The deposit appeared silver-white beneath a coat of black. A potential reading of this deposit against the standard solution of uranyl nitrate give a single potential of −0·470 volt.

The results obtained by plating on the same electrode after running a potential are given in Table I.

TABLE I.

| Volts. | $ND_{100}$ in amp. | Time (hours). | Weight of deposit. Grm. | Single potential (volt). |
|---|---|---|---|---|
| 4 | 3·64 | 3 | 0 0040 (*a*) | −0·472 |
| 5 | 2·16 | 1·5 | 0·0050 (*b*) | −0·471 |
| 6 | 2·16 | 1 | 0·0058 (*c*) | −0·478 |
| 7 | 2·16 | 1 | 0·0084 (*c*) | −0 479 |
| 8—9 | 2 16 | 2 | 0·0080 (*c*) | −0·475 |

(*a*) White under black. (*b*) White. (*c*) Black.

The single potential shows that the same material was ing deposited throughout. During the successive ex-rimenta a portion of the uranium oxyfluoride was reduced uranous fluoride, and this salt separated out during the ectrolysis. By thus depleting the solution of its ectrolyte it became necessary to increase the voltage to ep up approximately the same current density through-t. From the potential of the clear white and that of blackened deposit it is evident that the two deposits not the same. The potential of the blackened deposits rees with those obtained from the nitrate solution in yl alcohol, and also the deposits from the double nide and oxalate in aqueous solution.

(To be continued).

## EQUATION OF CONDITION.

By FRED. G. EDWARDS.

THE usual concept of the mean molecular heat of gases is given by the formula $c_v = a + bt$. For oxygen and nitrogen $a = 4·9$ at 0° C., and Pier gives the value $b = 0·00045$. Nernst's table for the simpler gases (Sackur's "Thermo-chemistry," p. 72) is constructed with $b = 0·000$ and $b = 0009$, &c. These three linear equations are the chords to a curve concave upwards, and only one intersection is determined, namely, 0° C. The equation to the curve is $m^x = k/\log T$; where $m = 5·95/y$, or $m = 4 - (2y/2·975)$, below, or above $y = 2·975$. For certain gases $x = 0·76384\ A^{\frac{1}{5}}$, giving the following values for $x$ and $k$.

TABLE I.

| Unit. | $x$. | $k$. | $y=2·975$. Absolute. | Centigrade. |
|---|---|---|---|---|
| H .. .. .. | 1·0 | 6·17 | 1217 | 944 |
| $\frac{1}{2}$CO = N. .. | 1·29486 | 7 75132 | 1443 | 1170 |
| O .. .. .. | 1·33 | 7 9309 | 1428 | 1155 |
| $NH_3$ .. . | 1·348 | 5 33978 | 125·2 | −47 7 |
| $\frac{1}{2}$HCl .. .. | 1·36162 | 8·1157 | 1442 4 | 1169 4 |
| Cl.. .. .. | 1·55525 | 7·43161 | 332 9 | 59 9 |

The resultant temperatures at $y = 2·975$, derived from *atomic* heat, are deduced from the equation. The fact that the value of $x$ for hydrogen appears to be unity is important for subsequent theory. The fact that the above gases require a large variation in the value of $x$ indicates a special constitution; and that the same value applies or not to their solid and liquid phases, can be ascertained from the specific heats. The value of $x$ for the compound gases $H_2O$, $SO_2$, and $CO_2$ is the same, as for liquids and solids generally, namely, $0·0698\ A^{\frac{1}{5}}$, with the following results. The specific points where $m$ is integral gives the temperature generally where change of phase and consequent recalescence should occur for any specific pressure.

TABLE II.

| Unit. | $x$. | $k$. | $y=2·975$. Absolute. | Centigrade. |
|---|---|---|---|---|
| $H_2O$ .. .. | 0·1216 | 2·7113 | 309 | 26 |
| $SO_2$ .. .. | 0·1603 | 2·68146 | 218·1 | −54 9 |
| $CO_2$ .. .. | 0·1550 | 2·50 | 175·8 | −97 2 |

From the equation $(5·95/y)^x = k/\log T$—

$$y = 5·95 \log T^{-x}/k^{-x}$$

$$\frac{dy}{dT} = 5·95\ k^x/xT,$$

but for hydrogen $x = 1$.

$$\therefore\ \frac{dy}{dT} = 5·95\ k_1 T^{-1};$$

where the value for $k_1$ is the logarithm of the temperature at which $y = 4·4625$. The corresponding logarithm for all other substances should be given by $k^x/x$. The term $k$ is a constant only while the volume is a constant.

$$\therefore\ \frac{dy}{dT} = 5·95\ v_1^{-1}\ T^{-1} = 5·95\ p_1 T^{-1},$$

or generally—

$$\frac{dy}{dT} = 5·95\ v^x/xT = 5·95/xp^x T:$$

where $p$ = gas pressure, intrinsic pressure, or surface tension, $v$ = volume, or $v^{-1}$ = density. The molecular velocities vary with $k^x/x$ from the unit where $m = 1$, where the units of temperature, pressure, and volume should also be determined, but the above equations do not apply below $m = 2$. The general equation is—

$m^x = k/\log T = 1/v \log T.$

$v = 1/m^x \log_e T.$

$\frac{dv}{dT} = \frac{T}{m^x}$ (where $v$ = unity at $m = 1$ at constant pressure).

$\frac{dp}{dT} = \frac{m^x}{T}$ (where $p$ = unity at $m = 1$ at constant volume).

$\therefore pv = m^x T.$

For monatomic gases $m^x$ = constant. Also for the gases in Table I. $m$ is practically constant over a considerable range of temperature, so that $pv = RT$. The densities of polyatomic gases would be proportional to their atomic weights if compared at relative temperatures, where $m$ = any integral or fractional constant.

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## AN INTERESTING OCCURRENCE OF MANGANESE MINERALS NEAR SAN JOSE, CALIFORNIA.

By AUSTIN F. ROGERS.

For some years a huge boulder of manganese ore situated on the bank of Penitencia Creek below Alum Rock Park, which is about five miles east of the city of San Jose, Santa Clara County, California, bore a placard which proclaimed it to be a meteorite. All geologists familiar with it knew that the so-called meteorite was simply manganese ore, for it showed a dull black mineral recognised to be psilomelane, the common manganese mineral of the Franciscan formation of the Coast Ranges of California. In the autumn of 1918, when restricted shipping facilities created an urgent demand for domestic manganese ores, the city of San Jose, owner of the land on which the boulder was located, at the request of the Government, decided to dispose of it. Several hundred tons of high-grade manganese ore was obtained from it and shipped to a California steel plant.

(The ore shipped varied in manganese content from 43·2 to 63·5 per cent and averaged 52·6 per cent, according to Dr. W. C. Bailey, City Manager of San Jose, to whom I am indebted for this information).

My attention was called to the manganese ore of an "Alum Rock meteorite," as it was known locally, by a resident of San Jose, who presented me with a small specimen from its interior. Great was my surprise to find that this specimen was largely pyrochroite, $Mn(OH)_2$, and not psilomelane. As soon as opportunity was afforded, a visit to the locality was made and a suite of specimens obtained. The minerals identified in the boulder are: *Tephroite, hausmannite, pyrochroite, ganophyllite, rhodochrosite*, barite, and psilomelane. Of these the first four are very rare, except at Langban, Sweden, and ganophyllite is known only from this locality. Hausmannite is not certainly known in the United States, but has been reported from San Luis Obispo County, California. Pyrochroite occurs at Franklin Furnace, New Jersey. Tephroite in this country has been found in but two localities, Franklin Furnace and central Texas.

After the minerals are described, an attempt will be made to determine the relations of the minerals to each other and the character of the deposit. The facts brought out in this discussion may have a bearing on certain geological problems pertaining to the Coast Ranges of California.

### *Description of the Minerals.*

*Tephroite.*—Tephroite as a megascopic constituent of the ore is rare, but in several specimens it was noted as a massive greyish red mineral, which was at first thought to be rhodonite. It lacks, however, the perfect cleavage of rhodonite, a hand lens showing but traces of imperfect cleavage surfaces. It also has a faint resinous lustre different from the vitreous lustre of rhodonite. The specific gravity of an impure specimen was found by a rough determination to be about 3·75, but carefully selected fragments with only traces of visible impurities gave a specific gravity of 4·010 (determined on 1·5 grms. by pyknometer at 25° C.).

The tephroite is very easily soluble in dilute HCl with gelatinisation, and the solution gives an abundant test for manganese and faint tests for iron, calcium, and magnesium.

The indices of refraction, determined by the immersion method, are greater than 1·740. Thin sections show almost colourless anhedra, with interference colours ranging up to bluish-green of the second order, which proves that the double refraction is higher than that of rhodonite ($n\gamma - n\alpha = 5·011$), but lower than that of olivine ($n\gamma - n\alpha = 0·036$). Polysynthetic twinning is a prominent feature in the thin sections, a property not previously reported for tephroite. In some areas the twinning resembles the albite twinning of plagioclase, but more often it resembles an intergrowth of two minerals. The twinning is recognised largely by differences in interference colours rather than by extinction angles.

Although not often visible in the hand specimens, tephroite in isolated anhedra surrounded by alteration products is seen in many thin sections. For this reason it was probably present in abundance in one stage of the history of the deposit, but on account of its ready alteration only remnants of it are left.

*Hausmannite.*—Hausmannite, on the other hand, can be recognised in many of the hand specimens, and in some it is by far the most abundant mineral present. It occurs in crystals, which vary from euhedral to anhedral, but are usually subhedral. A few small (1 to 2 mm. in size) euhedral crystals were found, and prove to have the following forms: (001), (113), (111), (221), with the unit tetragonal bipyramid (111) as the dominant form. The measurements given in Table I. were made with the reflection goniometer.

TABLE I.—*Interfacial Angles of Hausmannite.*

| | No. of Meas. | Meas. | Record. |
|---|---|---|---|
| (001) ∧ (111) .. | 4 | 58° 32½′ | 58° 32′ |
| (001) ∧ (113) .. | 1 | 28 25 | 28 34½ |
| (111) ∧ (1̄11) .. | 4 | 74 5 | 74 10 |
| (001) ∧ (221) .. | 1 | 71 6 | 72 59 |

In thin sections most of the hausmannite is opaque, but on the edges of the sections some of it is translucent and dark red. A few of the deep red crystals are dark between crossed nicols, but most of them are doubly-refracting with definite extinction four times in a revolution. Polysynthetic twinning was noted in some sections.

Crushed fragments of the hausmannite examined with the polarising microscope under ordinary conditions appear opaque, but in direct sunlight between crossed nicols many of them are translucent dark red. (The crossing of the nicols shuts off the brilliant reflection of the sun, and so the fragments are visible). They are doubly-refracting, but the colour of the mineral masks the interference colours. This method may be of service in determining some of the submetallic minerals which are opaque in ordinary light, provided, of course, they are doubly refracting.

The hausmannite is readily and completely soluble in HCl with the evolution of chlorine.

*Pyrochroite.*—The pyrochroite occurs in euhedral crystals (up to 5 mm. in size) in cavities and in cleavable plates in masses. The euhedral crystals are thin lenticular, without well-defined faces. A few are hexagonal in outline, with a low vicinal rhombohedron. In most specimens the pyrochroite is a bronze-red, but soon changes to black on exposure. Freshly-broken specimens often show the deep red reflections that give the name to the mineral. In a few cases it is colourless or pale green. It has a perfect cleavage in one direction.

The index of refraction of cleavage flakes was found to be $n\gamma = 1.733 \pm 0.003$ (sodium light), which is a little higher than the recorded value (1·723). One of the cleavage flakes gave a negative uniaxial interference figure in convergent light.

In thin sections the pyrochroite is colourless to salmon-coloured. The areas without cleavage are non-pleochroic, and are either dark between crossed nicols or have very weak double refraction, while the salmon-coloured areas showing cleavage are pleochroic from nearly colourless to deep yellowish-red. The double refraction determined by finding the thickness of a section from the highest interference colour of associated barite is about 0·04. The direction of the cleavage traces in thin sections is parallel to the slower ray which checks the optically negative character determined above.

The pyrochroite is also soluble in HCl with the evolution of chlorine, and gives abundant water in the closed tube.

Along cleavage planes the pyrochroite in thin sections is seen to be altered to an opaque brown oxidation product. This is a hydrous manganese oxide of some sort, and may possibly be the amorphous equivalent of manganite which represent a higher state of oxidation of manganese than pyrochroite.

*Rhodochrosite.*—Rhodochrosite occurs both in euhedral crystals along seams and in granular masses. The euhedral crystals are pink in colour, and have the form of the negative rhombohedron ($0\bar{2}21$), a common form for calcite, but a very rare one for rhodochrosite. It usually occurs alone, but in a few cases narrow faces of the positive unit rhombohedron ($10\bar{1}1$) were observed. The rhombohedron ($02\bar{2}1$) was identified by the fact that the cleavage rhombohedron truncates its polar edges. This was checked by the following measurements made with the simple reflection goniometer devised by the writer:—

$$0\bar{2}21 \wedge \bar{2}02\bar{1} = 100° \text{ calc.} = 99° 54');$$

$$02\bar{2}1 \wedge 20\bar{2}\bar{1} = 80° \text{ (calc.} = 80° 6').$$

(*Science*, 1908, xxvii., p. 929. This little device constructed out of a Penfield cardboard goniometer often saves the necessity of using the large reflection goniometer when approximate measurements suffice).

Some of the specimens are made up largely of fine-grained reddish grey rhodochrosite, which shows minute cleavage surfaces. A few light reddish grey specimens seem to consist of rhodochrosite and barite. Rhodochrosite must be common in many specimens, even when not visible to the unaided eye, for they effervesce in hot HCl, and thin sections show the presence of a rhombohedral carbonate.

*Ganophyllite.*—This very rare mineral, heretofore known only at the original locality (Langban, Sweden), was found along seams with cleavable barite as brownish-yellow distorted tabular crystals. It was identified by the index of refraction $n = 1.723 \pm 0.003$—recorded values $n\gamma = 1.730$; $n\beta = 1.729$; $a$ is perpendicular to the plates, so that $n\ a$ is not easily obtained. This determination took only fifteen minutes, which is a testimony to the value of optical methods in determining minerals in fragments by means of the polarising microscope. The writer had never seen ganophyllite before, and had scarcely heard of the mineral. The plates are pale yellow, non-pleochroic, and give a biaxial interference figure in convergent light. The optical determination was checked by qualitative tests for aluminium, manganese, and water.

*Psilomelane.*—Massive black and somewhat banded psilomelane makes up the list of manganese minerals that can be positively identified. Before it was broken up to be used as manganese ore the whole boulder, or so-called meteorite, was supposed to be psilomelane, but it turns out that only the outside crust is psilomelane.

*Barite.*—Barite seems to be practically the only mineral of the deposit which does not contain manganese. It occurs in euhedral crystals along seams and in thin sections, and it also proves to be interspersed through many of the specimens. The euhedral barite crystals are of two different habits—(1) highly modified crystals of equant habit, with (110), (111), and (001) as prominent forms; and (2) crystals of pyramidal habit with the unit bipyramid (111) as the dominant form, a very rare habit for barite.

*Other minerals.*—There are a few other minerals, which occur in such small quantities they have not yet been identified. Some of the massive grey specimens are apparently homogeneous, but prove on microscopic examination to be microcrystalline aggregates. Mineralogical literature is so full of descriptions of so-called new minerals based upon such material that the writer has refrained from an attempt to characterise these substances until better specimens can be obtained.

*Paragenesis of the Minerals.*

By this term I mean the relation of associated minerals, not simply the order of succession, which is only one phase of these relations.

After the minerals of a rock or mineral deposit have been identified, the next thing to do is to determine the relations of the minerals to each other. This is often a difficult task, but it is equally important with the determination of the minerals.

The order of succession of the minerals of this manganese deposit is as follows:—Tephroite, hausmannite, rhodochrosite, pyrochroite, and psilomelane. The place of barite cannot be fixed definitely, but it seems to be earlier than the rhodochrosite. It probably occurs in several generations.

Tephroite is undoubtedly the earliest formed mineral present. It was probably abundant at one stage in the history of the deposit, but is now present as residual specks. The alteration products of the tephroite are indefinite, ill-defined substances, to which no name can be assigned.

Hausmannite, although occurring in euhedral crystals, was probably formed later than the tephroite, for vein-like areas of hausmannite surround and extend into areas of tephroite, and there is no evidence of more than one generation of hausmannite.

Rhodochrosite is certainly later than the tephroite and hausmannite, for it occurs in veinlets cutting these minerals. It is often associated with barite, and replaces the barite.

The pyrochroite is a relatively late mineral, for it occurs as a replacement of hausmannite, and is common in euhedral crystals along seams. It is also later than a part at least of the barite.

The pyrochroite in turn yields to a brown hydrous manganese oxide, which may possibly be the amorphous equivalent of manganite.

Finally the psilomelane was formed as a crust on the exterior of the boulder probably after it was detached from its place of origin.

The above order of sequence seems reasonable in view of the fact that most of the minerals show a general increase in the state of oxidation of the manganese from the early to the late stages. In the tephroite we have the manganous state ($2MnO.SiO_2$); in hausmannite, we have an intermediate condition ($Mn_3O_4$), and finally in psilomelane a still higher state of oxidation ($MnO_2$).

The boulder undoubtedly represents a block detached from its original location in the hills above in some past, probably remote, period. With the exception of the barite, it contains no gangue minerals, although lacking in chalcedony and quartz. It is probably of Franciscan age, as are all the other manganese deposits of the Coast Ranges. The occurrence of hausmannite at a mine in San Luis Obispo County (*Bull.* lxxvi, California State Mining Bureau, 1918, p. 14), and an undescribed occurrence of tephroite near Mount Diablo, both in rocks of Franciscan age, gives credence to this belief. Franciscan cherts and jaspers outcrop two to three miles east of the spot in which the boulder is located. Several manganese deposits are found here,

but as far as examined they are different mineralogically from the so-called meteorite.

The typical occurrence of tephroite and hausmannite is in contact-metamorphic deposits. No limestone is present in the vicinity of Alum Rock Canyon and none was found in the boulder. Limestones of Franciscan age are known at various places in the Coast Ranges, but they are unmetamorphosed.

Although some doubt is attached to the original occurrence of this manganese ore, the presence of tephroite and hausmannite points to the high-temperature nature of the deposit. The rhodochrosite is undoubtedly a hydrothermal mineral, and the psilomelane doubtless was formed by meteoric waters at a very late period. The pyrochroite is intermediate in age between the rhodochrosite and the psilomelane. Was it formed by meteoric waters or by hydrothermal solutions? This question cannot be answered definitely, but it is believed to have been formed at a late hydrothermal stage. It is altered to a later hydrous manganese oxide, and so is unstable under oxidising conditions. In fact, specimens alter when exposed for several days. The presence of a large amount of water—$Mn(OH)_2$, $H_2O$ = 20·3 per cent—is no proof that a mineral is formed by meteoric waters.

Such is believed to be the essential history of this interesting deposit or rather remnant of a deposit, though a number of questions cannot be settled for lack of sufficient data. The existence of this boulder makes it probable that some, if not many, of the manganese deposits of the Coast Ranges of California are of high-temperature hydrothermal origin. The prevalence of psilomelane may be accounted for by subsequent alteration of the hydrothermal minerals by meteoric water.—*American Journal of Science*, xlviii., 443.

## BRITISH CHEMICAL STANDARDS.

### Analyses made at the Research Department, Royal Arsenal, Woolwich.

The Superintendent of Research, Royal Arsenal, Woolwich, who is now co-operating in the standardising of these and other steels, has had them tested in the Government Research Laboratory at Woolwich, and has supplied the results given in the accompanying table. They are, of course, not included in the general averages shown when the standards were issued, but will serve in conjunction with them as a guide for firms doing work for the War Office and others. The Superintendent wishes it to be made clear that the homogeneity of the bulk of standardised turnings represented is not in any way guaranteed by the War Office. The homogeneity has, of course, been fully verified by the firms who provided the bars and by Messrs. Ridsdale and Co.

| Standard. | Carbon (per cent). Direct combustion *in oxygen* | Silicon (per cent). Solution in aqua regia. *Single evaporation only.* | Sulphur (per cent). Total by *oxidation.* | Phosphorus (per cent). Direct molybdate without evaporation: Converting to $PbMoO_4$. | Phosphorus (per cent). Direct molybdate without evaporation: *Alkalimetric* finish. | Manganese (per cent). Bismuthate *volumetric.* | Manganese (per cent). Ford and *Williams.* | Nickel (per cent). Dimethylglyoxime separation *and cyanide* titration. |
|---|---|---|---|---|---|---|---|---|
| "B4" .. | 0·396 | 0·027 | 0·045 | — | 0·103 | 0·737 | — | — |
| "N" .. | 0·170 | 0·127 | 0·032 | — | 0·038 | 0·437 | — | — |
| "I" .. | 0·517 | — | — | — | — | 0·733 | — | — |
| "O" .. | 0·327 | — | — | — | — | 0·590 | 0·590 | — |
| "H" .. | 0·433 | — | 0·046 | — | 0·035 | — | — | — |
| "S1" .. | 0·927 | — | — | 0·051 | 0·053 | — | — | — |
| "T" .. | — | — | — | — | — | — | — | 3·36 |

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## ZIRCONIA.

### Statement as to its Industrial Development.

Zirconia, the new refractory (about which so much was written during the war), was discussed, from the point of view of its development in industry, in a paper by Mr. H. E. Coley, of London (which was read by Mr. Ramsden), before the members of the Birmingham Metallurgical Society at the Chamber of Commerce, Birmingham, on Thursday, December 18.

Mr. F. C. A. H. Lantsberry, F.I.C., who presided, urged that the metallurgical and ceramic industries were greatly in need of better refractories.

The Author said if one assumed that zirconia had descended from the pedestal of the rare earths lists, and that literature was correct and that it was the almost ideal refractory material, why was it not largely used in the metal industry? The commercial man said the cost was too high; he was not, however, concerned with the statements that zirconia formed carbides and nitrides readily, and indulged in other complex reactions only seen within a chemist's beaker. The two principal sources of zirconia ore were the oxide of zirconia *plus* gangue, and zirconia silicate known as zircons. There had not, as yet, been devised a process with a cost production figure low enough to warrant pure zirconia oxide being used for refractory bricks in the furnaces, and therefore it was improbable that pure $ZrO_2$ refractory bricks would be available for the metal industry. It was obvious that the $ZrO_2$ must be cheapened either by leaving some of the impurities with it or adding other materials of an inoffensive character. Showing samples of zirconia which had been through an operation for the removal of the iron and free silica (and which had a breaking down point under heat at a temperature of 2300° C.), the author said the whole question of the use of zirconia on a large scale and for heavy furnace work depended on the question of cost. Given a brick having a softening point of 2300° C. and none of the objectionable qualities of other refractories, could the metallurgist afford to use it? Zirconia was somewhat like a sharp sand, and the problem of plasticity had been largely solved. Zirconia in common with most other refractories could be influenced as to its shrinkage by the addition of grog, *i.e.*, pre-burnt and ground zirconia. The essential point was that the grog should have been fired to the same temperature as that to which the bricks were to be fired. The firing temperature was not governed by the melting-point of the material but by the temperature of employment. The grog firing temperature was determined by the kiln firing temperature, and the kiln firing temperature was determined by the temperature of the furnace in which the zirconia shapes were going to be worked. It was worthy of note that there was not any appearance of the hackly fracture one would expect from the addition of grog, except where vitrified grog had been added, and then these granules were a source of weakness, not strength. The ground grog completely united

the raw material, and a homogeneous and plain structure results which tended to strength. The gas furnace was suitable for the firing of zirconia brick shapes. Much had been said, observed the author, about the formation of carbides of zirconia during firing, but there was not any evidence those carbides formed below fusion-point. The mistake had probably arisen on account of the curious capacity of zirconia to absorb carbon. Black bricks could be obtained by firing the zirconia bricks in a strongly reducing atmosphere, carbon monoxide being freely available, with the result that carbon deposited in the zirconia bricks gave a black colour. That colour might be completely removed by firing in an oxidising atmosphere.

The point had been raised—Could the zirconia material from which the various shapes were made be used *in situ*? If the material could be shaped to the furnace requirements on the spot without the manufacture of special shapes the cost would be materially decreased. The answer was that that could be done, but it must not be expected that the zirconia material was going to set under such conditions without cracks appearing. With adequate preparations a workable job could be obtained. A highly finished zirconia built furnace must be properly designed in sections, made in those sections baked separately and accurately fitted together. The position of zirconia—which the war brought forward and had held back—was to-day as follows:—A zirconia material could be produced which so treated could be moulded into any suitable shape; the shapes could be baked to present a workmanlike finish and surface, and when so baked the shapes had a melting-point of not less than 2300° C., a low coefficient of expansion; a low conductivity; a resistance to slags better than other refractories; the property of being heated and cooled alternatively and rapidly without deterioration; and a capacity to resist very great pressures cold, and a greater pressure hot than other refractories.

As to zirconium as a metal and an ingredient in alloys, he could not give any useful information because the effects of the results obtained were not yet established. The work was embryonic. During the war we were told that the great German guns were made of zirconium steel. Our American Allies found out all about it quickly, and after that there was little news. Ferro-zirconium was made and could be made, and some day the real inwardness of the application of zirconium as an alloy would be established. But he asked them to remember that if it was an ingredient in the manufacture of German armour plates, and it might have been, it could not be found therein. Released from its bondage with oxygen it was a wayward and difficult material. If it could not have its oxygen it would take nitrogen in exchange, or silica. In short, it was an excellent scavenger, and therein perhaps was its ultimate destination. The production of ferro-zirconium was, in fact, only the beginning and not the end of the matter.

DISCUSSION.

Mr. BRADFORD thought the chief disadvantage of zirconia for commercial use lay in the question of cost. Were there good supplies in Brazil? The extraordinary advantages of zirconia over the ordinary well-known refractories were so much greater that even an enormously higher initial cost might in the end be the more profitable, although the difficulty would be to make manufacturers realise that. He believed that a semi-purified zirconium ore would be adequate for ordinary commercial purposes.

Mr. H. HAYES believed the earth, zirconia, would be a great improvement on present refractories, most of which gave way, and caused delays, in the furnaces for the melting of nickel and nickel-silver alloys.

Mr. A. E. BROUGHALL commented upon the wonderful properties of the refractory, and urged that if it did what was claimed cost would not prevent its use. Cost did not restrict the use of high speed steel.

Mr. A. BRAZINET enquired how many heats with brass could be done with the same crucible.

Mr. J. E. LESTER said he wanted to see where this rare earth was leading—whether its use was likely to become a commercial proposition, or whether it was to be merely academic.

Mr. RAMSDEN, in reply, said the cost of zirconia was not anything like double that of the other refractories, while the life of it was probably ten times greater than most, and four times greater than the best. The linings of crucibles would be of zirconium material, not of zirconia alone; the mixture gave a longer life. All the severest tests possible with other refractories place zirconia easily in the predominant position; in many instances it remained intact when other refractories gave way repeatedly. The cement was of the same material as the bricks, and applied wet a perfect bond was obtained. Zirconia was porous to water but not to salts, and they were not aware that it absorbed metallic fumes. There was no shortage in Brazil of the zirconia earth. Spraying zirconium preparation on fire-brick was not effective; what was wanted was a nice working face on the lining. With the material plastic, cracks after six heats were easy of repair; there was not that glazing as with ordinary refractory material. It was not necessary to line the lids.

To the author and Mr. Ramsden a hearty vote of thanks was passed.

## RECONSTRUCTION OF A SULPHATE OF AMMONIA PLANT.

A PAPER on the reconstruction of a sulphate of ammonia plant was read by Mr. Joseph Poulson, Works Chemist at the Stafford Corporation Gas Works, on Thursday, December 18, before the members of the Midland Junior Gas Association at the Council House, Birmingham.

The Author pointed out that the previous plant was badly damaged by subsidence. Regarding the re-erection of the plant, he said the sections of the square still were thoroughly cleaned, and the threads of all bolts and studs run down with a die nut.

The erection of the stills was then proceeded with. The jointing material used consisted of two parts glaziers' putty, one part vulcan cement, one part red-lead mixed with boiled linseed oil, and in this a soft cotton string was embedded. The lining still consists of cylindrical body, shallow domed top, conical bottom, and inlet and outlet pipes. A 6-inch sludge outlet pipe and valve were fitted to the conical bottom and the pipe led into the spent liquor pits at the back of the house.

The new heater is 3 feet diameter by 8 feet high, and is of cast-iron throughout. It consists of flanged cylindrical body, and fitted with flanged cap-shaped ends. The waste gases pass around 5-inch heavy cast-iron pipes, each end being jointed in sockets cast on a diaphragm plate, which is bolted between the end and body of the heater. The liquor is heated on its passage through the inside of the pipes.

The sulphate store was lead lined, namely, bottom and sides, the latter to a height of 10 feet, all joints being well lead-burned as laid. By carrying the lead bottom up to the height of a foot around the sides, this enabled a thinner lead to be used for the side sheets, which are burned to the lead floor. The lead was solidly worked into the channel previously made, and this would carry away any drainage that may occur from the store. The floor sheeting was continued to the saturator, &c., staging, and carried up the wall on the two sides as in the store. The saturator pier was lead covered, and the mother-liquor well lined, the latter with 10-lb. lead. Around the other sides of the platform wooden rolls were made to a height of ten inches, and the lead sheeting of the floor worked over these. The joints were burned with a fine oxy-coal gas flame. In this manner the floor of the stores and staging constituted a continuous tray, drained by means of the fall given to the floor, and the channels into the mother-liquor well, which has a capacity of 150 cubic feet.

The saturator is of the open type, having a well for ejecting, the size being 4 ft. 9 in. by 3 ft. 6 ft. by 3 ft. 4 in. deep, exclusive of well. The body is formed from plates 1¼ inches thick, with an apron of 1¼ inches, and the bottom and well of 1⅝ inches lead. It is made of the best refined Pattisonian process chemical plate lead, with a minimum of seams, special attention given to the strengthening and webbing where needed to ensure its keeping shape, and all is securely timber braced. The well is encased in a strongly bolted pitch pine cradle, the saturator sitting solidly on same.

The saturator is fitted with double detachable ammonia pipes, detachable acid and steam pipes, detachable steam ejector, man-hole and man-lid, waste gas outlet, and flange. With this type of saturator not only can the salt be ejected, but, being of the open type, can be adapted to hand fishing should the ejector need repairs or renewal. The double ammonia pipes are advantageous, both for long life and being carried along the back and two sides give that equalised distribution of the ammonia gases so desired. The perforated (leaden) steam-pipe has proved useful for dissolving the crystals that form round the ammonia pipes and saturator sides after the plant has been shut down. Also, by putting the steam on at intervals for half a minute when the saturator is salting, a better contact is given to the ammonia gases with the acid, and the salt is blown to the front of the saturator into the well. A steam ejector lifts the mother-liquor from the mother-liquor well into the saturator.

The dryer is of the steam-driven type, with lead-lined steel shell and perforated copper basket of 48 inches diameter, 16 inches deep, with hinged copper doors fitted in the bottom. Through these the sulphate is discharged into the shoot below. The dryer is suspended on cast-iron standards which are bolted to a cast-iron bed-plate, and this, in turn, fixed on two larch timbers of 10 × 10 inches section, directly over the mother liquor well. The liquor extracted from the sulphate is conveyed through a detachable cast iron bend into the well.

The waste gas condenser was made of a straight run of 18-inch cast-iron spigot and socket pipes with ordinary run lead joints. Flanged pieces were used at either end, and these were drilled to receive flanged and socket pieces for the inlet and outlet pipes. The cooling is effected by water continuously pumped along the entire length of the condenser through a 1½-inch perforated pipe.

The waste gas purifiers were built in concrete at the front of the house, the base measuring 41 × 21 feet and having a thickness of 12 inches, and reinforced with expanded metal. Side walls were cast to a height of 2 feet 6 inches, and a central wall gave each purifier an internal measurement of 18 feet square. The supporting walls for the purifier grids measured 8 feet square and were built of 9-inch brickwork. Spaces were left in the brickwork so as to give extra distributing area for the waste gases.

New steam piping was installed throughout, and a new pressure reducing valve fitted to the branch leading to the stills. A Wilton automatic spent liquor valve was fitted to the main still. The coupling up of the various make-up pieces completed the re-erection of the plant. The covering of the stills with non-conducting composition is now in progress.

Improvements are to be observed in the working of the plant. The increased efficiency of the heater and main still have resulted in a decided economy of steam, as a waste liquor was got practically free from ammonia with a pressure of 10 lbs. on the steam branch to the stills, whereas they previously worked at 16 to 18 lbs. A substantial increase of mother-liquor has given us a corresponding increase of sulphate made, and the larger sized saturator has proved beneficial both for increase and quality of the sulphate made. The dryer runs free from vibration, and gets its maximum speed of about 900 revs. per minute in thirty to forty seconds from starting, and after four minutes run gives a moisture content in the sulphate of under 2 per cent. The Wilton automatic spent liquor valve works very satisfactorily, and is an improvement on the old seal pot.

A process for making neutral dry sulphate is being proceeded with, and a salt practically neutral is being made.

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## ECONOMIC STATUS OF THE CANADIAN CHEMIST.

The Canadian chemist finds himself standing at the dawn of what seems a new era, back of which the dark shades of night cast a pall over all that is past. He finds it hard to foretell what the day may bring, for, professionally, he has had no yesterday, and his stumbling progress during the night has brought little of value for his guidance now that his day has dawned. Lack of opportunity has dwarfed his ambition in some instances; the failure of the people to appreciate his ideas and technical worth has developed a reticence which now often retards his progress. The lack of opportunity has been due, in part at least, to our great wealth of natural resources, for since the first settlers arrived in Canada it has been possible to gain a comfortable livelihood by ordinary industry and without the necessity of much research. Such industries as have grown up have used natural supplies lavishly, and have not been under the necessity of working economically or of finding profitable uses for their by-products. Profits have been good, and it has been always a simpler matter to waste than to work the materials produced incidentally in the course of the manufacture of their main products.

In all this the chemist has had little place. Progress to him means conservation and development, the unfolding of the bud into the beauty of the flower. But there comes a time in every wasteful nation's life when, be it ever so little, a halt is called in extravagant expenditure; then the chemist has a chance. Thus it is that the older countries of the world have been the leaders in chemical research and scientific progress, and the countries most limited in easily available resources have distinguished themselves among their fellows.

Canada has been no exception among the younger and supposedly progressive nations of the world. Year by year dependence upon the older countries increased; more raw materials were shipped out, and more finished products imported. The war stopped much of our import business, and at first a great wail of distress went up; but that was unproductive of satisfactory conditions, and eventually our people went to work, the virility of the young nation asserted itself and great progress was made.

The chemist emerged. He was given a small job in which he saved the firm money and made things which previously had only been produced in foreign lands. A little of the old-time prestige enjoyed by the chemist returned and the Canadian chemist began to develop confidence in his own ability. He remembered that many prominent in industrial development in the United States and Europe were Canadians, graduates of Canadian universities, who, without honour in their own country, had crossed the border to be acclaimed as leaders. One does not have to go farther back than to the name of Robert Kennedy Duncan, that brilliant scholar and magnetic leader, who fathered industrial research in the United States.

So it was that the wasteful process of war in Europe created conditions in Canada favourable to the initiation of national scientific work. Parliament, in response to the nation's appeal, made a humble beginning by appointing the Honorary Advisory Council for Scientific and Industrial Research. The breadth of vision necessary for much advance has, so far, not been characteristic of our law-makers, and the work of the Council has been impeded. Industrially, Canada has made better progress, and to-day more than ever before, Canadian industries are

seeking the assistance of technically trained men, for experience gained during the stress of war has led them to see that money invested in chemical research is likely to return many times over in increased profits derived from better efficiency in their processes, and the utilisation of products formerly wasted. Better co-operation between science and industry may be looked for, and while the economic status of the chemist at the present moment is not good, the increased number of opportunities, now being provided by the captains of industry, makes his future assured. The Canadian Institute of Chemistry is welding the chemists together in a chain across Canada which will enable them better to cope with difficult questions involving their professional status; and the various other chemical societies, flourishing, reflect the new interest. Canada is a country of optimists, and optimism is the keynote of research and progress. If the foundations of research are well laid there need be little fear regarding the superstructure that capital will rear thereon, and the status of the chemist will no longer be a necessary topic for discussion.—*Canadian Chemical Journal*, iii., No. 12.

## CHEMISTRY AND AGRICULTURE.

This journal (*Canadian Chemical Journal*) cannot be said to have suddenly become interested in agriculture as a result of recent elections in the Province of Ontario. Agriculture in general has been one of the fields that has given the chemist in the past very large opportunities, and agricultural chemistry has for years been one large branch of the subject. We would point out, however, to those chemists who have found their work in other fields that the whole of agricultural chemistry does not consist in making analyses of fertilisers. Some of the most complex problems and those most pressing for solution are either directly or indirectly connected with the utilisation of soil, the feeding of animals, and the production of crops and food supplies. Like all other branches of chemistry, there are many side lines and much overlapping with other sciences, but on the whole a sound knowledge of the principles of chemical research are essential before much progress can be made in any line or difficulties overcome.

We have developed agricultural schools and experimental farms to a very fair state of efficiency, but it is not unfair to say that the various interests of these organisations has left but little energy for any real attacks on research problems. The perfection of the pure sciences in our agricultural colleges has lost much because they were so closely connected with a student body for the most part interested in what seemed to be more practical things, and also for the reason that no close connection was maintained with universities where more of the academic or research spirit might be imbued. Engineering has contributed to agriculture, practical farmers have been given better methods, better stock, and a keener ambition to develop the soil possibilities, and, on the whole, progress has been wonderful. Now, in order that it may be sustained, our facilities for the application and spread of general agricultural science must be increased, and above all more attention and more suitably trained Canadian minds should be directed towards the solution of basic problems and the development of the new in agricultural science. Most of the keenest weapons of attack will more than likely be found to be chemical.—*Canadian Chemical Journal*, iii., No. 12.

Röntgen Society.—An Exhibition of Radiographic Prints by Members of the Röntgen Society will be held at the Royal Photographic Society House, 35, Russell Square, London, W.C. 1, from January 6 to February 7. The Exhibition will be open daily (admission free) from 11 a.m. to 5 p.m., and on the evenings of January 6 and 13 till 9 p.m.

## HELIUM PRODUCTION.

*Bulletin* No. 178 C. of the United States Bureau of Mines gives an interesting account of the war development of plants for helium production—though, probably as a war measure, the name "argon" was substituted for helium, and the three experimental plants finally constructed became known as argon plants. It is explained that one of these, the Norton process, is the latest practicable development in liquefying and separating gases. The Linde process (Plant No. 1) depends upon the so-called Joule Thomson effect, obtained by the sudden expansion of a highly compressed gas through a small orifice, or nozzle, and the consequent cooling of the gas; the process being elaborated into a self-intensive or cumulative cycle of heat interchange by causing the cooled gas, on escaping, to circulate around the tube leading the initial gas into the apparatus.

George Claude, of Paris, conceived the idea of a liquefaction cycle with an expansion engine interpolated. Though the Joule-Thomson effect is used in the Claude cycle (Plant No. 2), its value is reduced to a minimum, because the compression of the gas in this system is lowered. The maximum cooling effect is produced by the expansion engine, because the compressed gas, on expanding in the engine cylinder, is made to do work, and thus its temperature is lowered.

In the Norton process (Plant No. 3) three expansion engines are used, liquid is throttled, and the heat interchanger and fractionating still are of new design.

In the Linde system an enormous expenditure of power is demanded to compress the gas in order to obtain the maximum effect of throttling; and this energy is then wasted. The Claude system requires much less compression power; but in this system the energy stored in the compressed gas is also dissipated. In the Norton system the requirement for gas compression is reduced to a minimum by the interpolation of the multiple-expansion engines, and what is needed is conserved and re-applied through the energy developed by these engines. Thus the maximum cooling effect is obtained at a minimum cost.

As the result of experiments made and work done, it is confidently expected that helium of the highest purity will soon be produced by Plant No. 3 on a large scale.—*Gas Journal.*

## NOTIFICATION OF EPITHELIOMATOUS AND CHROME ULCERATION.

Section 73 of the Factory and Workshop Act, 1901, requires every medical practitioner attending on, or called in to visit, a patient whom he believes to be suffering from poisoning by lead, phosphorus, arsenic, or mercury, or from anthrax or toxic jaundice, contracted in a factory or workshop, to notify the case to the Chief Inspector of Factories at the Home Office; and a similar obligation is imposed on the occupier of a factory or workshop to send written notice of every such case to the Certifying Surgeon and Inspector of Factories for the district.

The Secretary of State has now made an Order, in pursuance of sub-section (4), applying the provisions of the above section to all cases of—

(a) *Epitheliomatous ulceration* due to tar, pitch, bitumen, mineral oil, paraffin, or any compound, product, or residue of any of these substances, and

(b) *Chrome ulceration* due to chromic acid or bichromate of potassium, sodium, or ammonium, or any preparation of these substances, occurring in a factory or workshop.

1. *Epitheliomatous Ulceration.*—In general, ulceration of the skin is a term used to define a raw surface forming on the skin, which, in industrial employment, is not infre-

quently set up by the substances handled. Under appropriate treatment, at no matter what age, such ulceration usually heals quickly, and should it recur will again heal with rest and treatment.

In the case of those handling the substances named, however, especially when the workers are over thirty-five years of age and have worked for about ten years or more n particular operations exposing them to dust or liquids, the ulceration following on the skin irritation set up may not heal but spread over a larger area of the surface of the skin and extend downwards into the flesh. And this form of ulceration, among other places, occurs with relative frequency on the scrotum. It is then to be regarded as epitheliomatous or cancerous, and this is the condition to be notified.

The only method of treatment for these ulcers likely to be successful is operative, which should be undertaken as early as possible, and roughly the need for operative interference is a criterion by which to judge of the need for report.

Many workers coming into contact with the substances named are prone to inflammations of the skin, such as plugging of the orifices (hair follicles and sebaceous glands) leading to hard red raised lumps on the skin (papules) often with a black central spot (blackheads). These are most marked on the forehead, neck, and outer surface of the arms. Sometimes the continued irritation causes scattered patches of pigmentation or reddened areas on the face or forearms, or quite small warts form without ulceration or extension into the surrounding skin. These conditions do not come within the definition of "epitheliomatous ulceration," and it is not the intention that they should be notified.

2. *Chrome Ulceration.*—If chrome compounds and their solutions remain in contact with the broken skin (and sometimes even with a very sensitive skin in the absence of an obvious broken surface) they give rise either to a general eczematous ulceration or a circumscribed ulcer known as a "chrome hole." Both these conditions when *definitely ulcerative* will become reportable.

Recurring attacks of epitheliomatous and of chrome ulceration should be reported when they appear n a fresh place.

## GAS AS INDUSTRIAL FUEL.

Mr. H. R. Hems (Industrial Research Laboratory, Birmingham Corporation) read an interesting paper on the use of gas as a fuel in Midland industry before the members of the Midland Gas Association on Thursday, December 18, 1919.

The value of the gas furnace installation lay in its cleanliness, simplicity of control, and quality of work. A furnace with a capacity of from 200 to 250 lbs. of alloy had a gas consumption of approximately 1000 cubic feet per hour, and would bring down a pot of metal in two hours.

Gas furnaces for the hardening of pen-nibs were working most satisfactorily, and gas as a fuel was being increasingly used in all branches of the Midland glass industry. It was installed for the annealing operation in "lehrs" of varying capacity, and also for "glory holes" used for the finishing operations after blowing. One firm had had running for some years a tank used for the melting by gas of "batch" and "cullet" for the production of a cheap class of scent and sauce bottles and similar articles. The furnace is of special design, consisting of a long rectangular brickwork box divided into three sections. Into the first the glass is fed and has playing directly upon it two large high-pressure flames which did the preliminary melting operations; the molten glass flowing underneath the first baffle into the second and third chamber, and from the latter was taken off from two holes by the glass-blowers. The furnace was never let out except for Saturday afternoon and Sunday morning, when minor repairs had to be carried out; it burned approximately 1000 cubic feet per hour.

One of the most important applications of gas to industry, Mr. Hems said, was in connection with the nut and bolt trade high-temperature furnaces for forging of steel and wrought-iron bars, and the results were entirely successful. The number of such furnaces was growing rapidly in the "Black Country."

Staffordshire ranked among the noisiest and dirtiest of industrial workshops, and a clean and easily controlled industrial fuel, such as gas, was greatly appreciated.

The furnace, too, was becoming a familiar feature in various branches of the enamelling industry, and particularly for the enamelling of jewellery, meter and clock dials, and advertising signs. The ramifications of gas in industry were growing apace, and there were important developments with regard to tube-brazing (in the cycle and bedstead trades) and soldering.

# PROCEEDINGS OF SOCIETIES.

## CHEMICAL SOCIETY.

At a meeting held on December 18 at Burlington House, Prof. James Walker, F.R.S., read a highly interesting paper on "*War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes.*"

In his introductory remarks he observed that the pooling of results and of experiences gained by different departments and their utilisation for the common cause was one of the great features in achieving a quick success in the early days. During the time when the shortage of ammunition was acute, in the beginning of 1915, he approached the War Office with the suggestion that he might contribute to the production of that essential explosive, trinitrotoluol. Every assistance towards the execution of his proposal was afforded by Lord Moulton, and he undertook to supply 150 tons of T.N.T. within a stated period. A disused egg-preserving factory in the neighbourhood of Edinburgh was the site selected for the plant, and before the expiration of the time-limit, in October, 1915, he was able to deliver the agreed amount of 150 tons of T.N.T. However, they were discouraged from continuing their manufacture in the site selected, as it was pointed out to them that, should a German U-boat appear and start to shell the factory, they would be in direct line with the fire from the shore battery. Consequently another site was selected—close to the North British Railway's goods depôt—and at these new works they were able to produce no less than 30 tons a week in 1917.

With regard to the supply of nitrogen for the manufacture of nitric acid, this country was practically dependent upon the supplies of sodium nitrate received from overseas, and there were no plants for the manufacture of nitrates from atmospheric nitrogen, as was the case in Germany. One source of nitrogen, however, was available, in the shape of ammonia, and the catalytic production of nitric acid from ammonia was undertaken. Prof. Walker demonstrated by experiments the formation of nitric acid from ammonia. Some 25 per cent ammonia was placed in a flask, and when a hot spiral of platinum was introduced into the flask the platinum was seen to glow. On the other hand, if dilute ammonia were used the appearance of nitrous fumes was observed, and Prof. Walker demonstrated how, in the case of dilute ammonia being used, a nitrite is produced, which is not the case when concentrated ammonia is employed. It was found that when 10 to 12 per cent of ammonia is present in the air mixture the best results were obtained. Numerous slides illustrated the apparatus and the manufacturing

process. The mixture of air and ammonia was filtered through cotton-wool, as it was found that dust impaired the activity of the platinum catalyst. The latter took the form of platinum gauze, through which the mixture of ammonia and air was forced, only 1/1000 of a second being occupied in the passing, while the yield amounted to no less than 97 per cent. They had many difficulties to contend with; one, a minor detail, was that this process produced an extremely penetrating whistling sound. He humorously mentioned how they received one day a visit from a mechanic, who stated that he had not yet encountered any trouble he could not settle with a spanner, and they also received a postcard with the query, "Why don't you oil the d—d thing?" Originally, to make one ton of T.N.T. required 1·27 tons of nitric acid, the average for the country; but by the introduction of devices for the recovery of nitrous fumes they succeeded in reducing the amount of nitric acid required to only 0·95 ton in 1918, shortly before the armistice. The necessity of observing the strictest economy with the sodium nitrate supplied made the recovery of the nitrous fumes evolved in the course of producing T.N.T. a very important factor, and Prof. Walker demonstrated by slides the methods used in realising a recovery amounting to 93 per cent nitric acid from the fumes produced in the course of nitration. In conclusion, he remarked that academic chemists had done well in the war, and had shown that they could enter the manufacturing branch of chemistry if endowed with common sense, and were willing to listen to those who had practical experience and engineering knowledge. The chemist who had a sound knowledge of his profession would also possess the necessary business instinct, and the research laboratories of the Germans were not so much scientific, but rather an indication of excellent business methods, implying a co-ordination of both aspects of the chemical industry.—*Chemist and Druggist.*

## MEETINGS FOR THE WEEK

*Saturday, January 3.*

Royal Institution, 3. (Christmas Lectures). "The World of Sound," by Prof. W. H. Bragg.

*Monday, January 5.*

Society of Chemical Industry, 8.
Royal Geographical Society, 8.30. "The African Rift Valleys," by Prof. J. W. Gregory.
British Psychlogical Society, 2.30. "The Development of Mental Tests" by Dr. P. B. Ballard.

*Tuesday, January 6.*

Royal Institution, 3. "The World of Sound," by Prof. W. H. Bragg.
Royal Photographic Society, 7. "The X-Rays approached from a Popular Standpoint," by Dr. G. H. Budman.
Röntgen Society, 8.15.

*Wednesday, January 7.*

Royal Society of Arts, 3. (Juvenile Lectures). "Railways and Engines," by L. Pendred.
Geological Society, 5.30.

*Thursday, January 8.*

Royal Institution, 3. "The World of Sound," by Prof. W. H. Bragg.
Institution of Electrical Engineers, 6.
Optical Society, 7.30.

*Friday, January 9.*

Royal Astronomical Society, 5.

*Saturday, January 10.*

Royal Institution, 3. "The World of Sound," by Prof. W. H. Bragg.

B. Sc., 2nd Hons. Chemistry (London), 22, ex-Army, just completed Degree from College, desires Post with good prospects in Research or Works Laboratory. Good references. Details and salary offered to Stubbings, Fair Oak, Eastleigh, Hants.

Chemist, with high qualifications (Ph D., Ph.Ch.) and large experience as Analytical and Pharmaceutical Chemist, speaking many languages, wants Situation in London.—Apply to P. G., Strand Palace Hotel (Room No. 685), 371, Strand, London, W.C. 2.

Skilled University Biological Laboratory Attendant seeks Post. Highly recommended.—Address, L. A., Chemical News Office, 16, Newcastle Street, Farringdon Street, London, E.C 4.

Skilled Chemist wanted to take charge of Laboratory in large Cement Works in India Must be thoroughly experienced. Salary £500 a year (in Rupee equivalent), with unfurnished quarters Three years agreement; passage out and home.—Address, Maxted and Knott, Ltd, Consulting Cement Engineers, Burnett Avenue, High Street, Hull.

### LINEN INDUSTRY RESEARCH ASSOCIATION.

The Council give notice that they will proceed shortly to appoint the following:—

A RESEARCH BOTANIST,
A RESEARCH CHEMIST,
A RESEARCH PHYSICIST,

at commencing salaries of £500 per annum.

Application forms and further particulars may be obtained from the Director of Research for the Linen Industry Research Association, 3, Bedford Street, Belfast, to whom the applications for the above Appointments should be sent not later than January 18, 1920.

### THE UNIVERSITY OF SHEFFIELD.

DEPARTMENT OF GLASS TECHNOLOGY.

Applications are invited for the Post of ASSISTANT LECTURER AND DEMONSTRATOR in the Department of Glass Technology. Candidates should possess an Honours Degree or its equivalent, and should have had good training in methods of Chemical Analysis Special knowledge of Glass Technology not essential. Salary £300 per annum.

Applications should be sent to the undersigned, from whom further particulars may be obtained, not later than January 17, 1920.

W. M. GIBBONS,
Secretary to the Glass Research Delegacy.

If in good condition, Sixpence per copy will be paid for any of the undermentioned numbers of the CHEMICAL NEWS which may be forwarded to this office:—

3051, July 5th, 1918.
3056, September 13th, 1918.
3062, December 6th, 1918.
3064, January 3rd, 1919.
3066, January 17th, 1919.
3068, January 31st, 1919.
3069, February 7th, 1919.
3070, February 14th, 1919.
3075, March 21st, 1919.

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HE CHEMICAL NEWS

VOL. CXX., No. 3117.

## NOTES ON THE EVOLUTION OF PROTEINS.

By E. L. KENNAWAY, M.D., D.Sc., Middlesex Hospital, London.

*NTIL recent years evolution has been studied almost* :clusively by morphological methods. The most detailed ctures of evolution which we possess, namely, those iowing the gradual construction of the modern horse and ephant, have been brought together solely by the in- pection of bones; this is unavoidable in the study of *stinct forms, since the materials most valuable to the iochemist are not preserved in fossils.* The application f experimental methods, as in the study of genetics, for istance, has of course yielded results of the utmost alue, but the mode *of observation is still chiefly anatomi-* al; the subject of biochemical evolution is still to a ge extent untouched.

Since organisms which are, anatomically, very simple ill exist side by side with others which are very complex, ne would think it possible by the study of the composi- ion of both types to investigate the chemical basis of the *ransition from the one to the other.* One may consider ere the question of the evolution of proteins. During the ast seventy years an immense amount of labour has been *xpended in attempting to trace the course of the evolution* of animals; yet is it possible at the present day to give in account of the steps by which any mammalian protein, for instance the caseinogen of milk, has been produced?

Every protein which has been analysed is found to be composed of amino-acids. The amino-acids which have been established as occurring commonly in proteins are *seventeen in number* (see Note); the composition of these is given in Table I.

(NOTE.—Improved analytical methods will no doubt show *that the actual number is greater, but this scarcely affects the* considerations put forward in this paper. A new amino-acid ($\delta$-hydroxyglutamic acid) was discovered in caseinogen quite recently (1); it is omitted from the table because it has not yet been sought in other proteins. Normal leucine is also omitted because there are as yet very few data as to its distribution. Several others, in addition to the seventeen, have been described (Plimmer, "Chemical Constitution of the Proteins," 3rd Ed., Part I., p. 5). Of these, some (caseinic acid, caseanic acid, hydroxy-amino-succinic acid, hydroxyamino-suberic acid, dihydr-oxy-diamino-suberic acid, hydroxy-diamino-sebacic acid) are regarded by Plimmer as mixtures, and some others (diamino-trioxydodecanic acid, oxytryptophane) are probably *secondary products produced in the course of analysis.* The occurrence of amino-butyric acid is disputed. The remainder (dihydroxy-phenylalanine, di-iodotyrosine) are *so closely related to some which appear in the table that,* from the present point of view, they may be disregarded. The deficiency in the yield of pure amino-acids by Fischer's method, the yield amounting in many cases to not more than 50 per cent of the weight of the original protein, does not in itself offer any strong evidence of the existence of undetected amino-acids. The sources of loss, *especially in the final isolation and purification of the* individual amino-acids, are very serious, and it is note-worthy that the best yields—80 to 90 per cent—have been obtained from those proteins in which a large fraction of the molecule is made up of but one or two amino-acids—*e.g.*, wheat-gliadin with 35 per cent of glutamic acid, silk fibroin with 60 per cent of glycine + alanine; in such cases the summation of losses incurred in the isolation of a number of different acids is avoided).

TABLE I.

I. *Mono-amino-monocarboxylic Acids.*

1. Glycine .. .. $CH_2NH_2.COOH$
2. Alanine .. .. $CH_3.CHNH_2.COOH$
3. Valine .. .. $(CH_3)(CH_3)>CH.CHNH_2.COOH$
4. *Leucine* .. .. $(CH_3)(CH_3)>CH\ CH_2.CHNH_2.COOH$
5. Isoleucine .. $(CH_3)(CH_3\ CH_2)>CH.CHNH_2.COOH$

II. *Hydroxy-monoamino-monocarboxylic Acid.*

6. Serine .. .. $CH_2OH.CHNH_2.COOH$

III. *Diamino dicarboxylic Acid containing Sulphur.*

7. Cystine—
$HOOC.CHNH_2.CH_2—S—S—CH_2.CHNH_2.COOH$

IV. *Mono-amino dicarboxylic Acids.*

8. Aspartic acid . $HOOC.CH_2\ CHNH_2.COOH$
9. Glutamic acid. $HOOC.CH_2.CH_2\ CHNH_2\ COOH$

V. *Diamino-monocarboxylic Acid.*

10. Lysine .. $NH_2.CH_2\ CH_2.CH_2\ CH_2.CHNH_2.COOH$

VI. *Diamino-monocarboxylic Acid with Guanidine Group.*

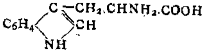
11. Arginine—
$HN = C<(NH_2)(NH.CH_2.CH_2\ CH_2.CHNH_2.COOH)$

RING COMPOUNDS.

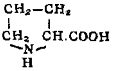
VII. *With Benzene Ring.*

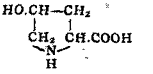
12. Phenylalanine $C_6H_5.CH_2.CHNH_2.COOH$
13. Tyrosine . .. $HO\ C_6H_4.CH_2.CHNH_2.COOH$

VIII. *With Indole Ring.*

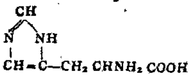
14. Tryptophane.


IX. *With Pyrrole Ring.*

15. Proline .. ..


16. Oxyproline ..


X. *With Imidazole Ring.*

17. Histidine ..


It is at once evident on inspection of Table I. that the organisms which synthesise amino-acids make a most extraordinary selection. The object of this paper is to direct to this point more attention than it seems to receive. The selection is remarkable in two ways,

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namely, (1) it is very limited as regards number, but (2) it is very diverse as regards structure. The total possible amino-acids of complexity lying within the range exhibited by the above ten classes must amount to a very large number. On what basis is this number reduced to seventeen or so? What is the meaning of the curious assortment of ring compounds? Why should two such compounds as, for instance, glutamic acid and tryptophane be chosen? The selection might have been much less, or much more, diverse; as it stands it has a curiously arbitrary appearance.

It may, of course, be said that the organism reaches this series of amino-acids, not by any process of selection from a greater number, but through its inability to synthesise any others. This might be so, though it scarcely renders the matter any less remarkable. But in view of the great synthetic capacity of plants, as shown by the structure of alkaloids, for instance, it is difficult to believe that other amino-acids could not be synthesised if they were required. Again, it may be said that the existing series of amino-acids has been selected because these, in combination together in varying patterns and numbers, give products which have the properties required of proteins. This is no doubt the case, but it is little more than a paraphase of what is obvious. To attain to any satisfactory knowledge in this direction one requires to know, firstly, what would be the characters of a "protein" made from an altogether different set of amino-acids, and, secondly, by what process of trial and error the organism succeeded in making the most suitable protein from the most suitable materials.

In seeking for information on the evolution of proteins the higher animals at any rate may be disregarded, since they appear under normal conditions to obtain their amino-acids, directly or indirectly, from plants; the limited powers of synthesis which they have been shown to possess are alluded to below. We have so little knowledge of the metabolism of the invertebrates that it is unsafe to assume anything as to their capacities in this respect. Thus, Loeb (2) has shown that the larva of the banana-fly can grow upon a medium containing no nitrogenous substance other than ammonium tartrate; the experiments did not decide whether this synthesis of protein was carried out by bacteria introduced with the eggs or not. The proteins of higher plants, the wheat-plant, for instance, are known to contain all the amino-acids. The problem of the evolutionary chemistry of proteins, in so far as it is accessible at the present day, resolves itself then to this: do the simplest plants (*e.g.*, bacteria, yeast) contain all the amino-acids present in the higher plants? If not, in what plants do the others appear?

Such information as is available no this question is given by Plimmer in a table in the latest edition of "The Chemical Constitution of the Proteins" (Part I., p. 127). This shows that various workers have analysed the proteins of five species of bacteria, of yeast, and of a mould (*Aspergillus niger*); and the table includes analyses of a protozoon (Noctiluca).* Table II. is adapted from that given by Plimmer; the composition of caseinogen, a protein peculiar to mammals, has been included for the sake of comparison. The analyses of yeast are those of three different workers†; with regard to four of the amino-acids they are not in agreement. Processes for the isolation of the protein were carried out in the cases of the first four bacteria in the table, and of Neuberg's (9) yeast; *Aspergillus niger* was extracted with alcohol and ether before analysis; in the remainder (Azotobacter and two yeasts) no separation of the non-protein constituents was attempted, so that unfortunately it is uncertain whether the amino-acids found in them are actually combined as protein.

* Analyses of the proteins of other protozoa would be of much interest; mycetozoa, such as Badhamia should provide a sufficient supply of material.

† Neuberg's (9) paper has been available only in the form of an abstract.

The table shows that the five bacteria, yeast, and the mould, taken together, contain all the seventeen amino-acids with the exception of oxyproline, the presence or absence of which was not established, and of serine and cystine, the presence of which was doubtful (in yeast). With regard to oxyproline, "only in a few cases has this compound been isolated from the products of hydrolysis of proteins, since its separation is extremely laborious" (Plimmer). It is recorded as present in 8 only of 157 analyses of proteins given by Plimmer. Moreover, proline is present in five of the seven micro-organisms, so that from the present point of view the presence or absence of its hydroxy compound is not of importance.

The absence of cystine from the bacterial proteins, which was established by the negative result of a test for sulphur, is noteworthy; this compound is present in numerous proteins of the higher animals and plants.*

As the synthetic powers of these organisms are of especial interest it is unfortunate that only two of them were grown upon media of known composition, namely, *Aspergillus niger* (on $MgSO_4$, $KH_2PO_4$, KCl, $FeSO_4$, $KNO_3$, cane suger) and Mycobacterium (on $MgSO_4$, $K_2HPO_4$, NaCl, glycerin, ammonium lactate, asparagin). The other bacteria were all grown upon agar or bouillon media, and no doubt some of them could not have dispensed with certain materials, perhaps of the character of vitamines, contained in these complex mixtures. Pringsheim (17) used ordinary "Pressbefe," and Meisenheimer (10) yeast which seems not to have been grown on special media; no details as to Neuberg's yeast (9) are accessible.

However, one must take these scanty results as all that are at present available. They show that the simplest organisms now existing do not contain a series of amino-acids any more primitive than that present in the higher organisms, except perhaps as regards the inclusion of cystine. One may suppose that the present apparently stereotyped series of utilisable amino-acids represents the stable outcome of a struggle long ago among simple organisms in which those which made a less suitable choice were beaten, and have passed away leaving no trace. We cannot know the biochemistry of the first organisms which appeared upon the earth; the experiments and discarded compounds of that time are lost. The selection of amino-acids must have taken place at an immensely remote period, for the earliest records which we have of the forms of life on the earth do not show us organisms which have any appearance of noteworthy difference in chemical composition from those which exist at the present day. Thus one of the earliest fossils, the brachiopod Lingula of the Cambrian period, is very closely related to a species now living. Structures regarded as fossil Algæ very similar to recent species have been found in still older rocks.† The doctrine of natural selection gives the impression that evolution proceeds throughout in a very gradual manner. But at the time when the amino-acids were first being produced and tested organic evolution must have proceeded very distinctly per saltum as each new compound was synthesised; natural selection would then act slowly and surely upon the organisms which made one or another choice, and thus the present series of amino-acids was delimited.

An obvious instance of the apparently "arbitrary" nature of the selection is the avoidance of the four-carbon acid, while the 2-, 3-, 5-, and 6-carbon acids are utilised, the 3-carbon acid moreover appearing in five forms (alanine, phenyl-alanine, tyrosine, tryptophane, and histidine) and the 6-carbon acid in four (leucine, iso-leucine, normal leucine, and lysine). Some of the amino-acids

* There is some indirect evidence that cystine is present in the protein of yeast, since this can serve as the sole protein food of rats (25).

† Walcott, quoted by Adami, "Medical Contributions to the Study of Evolution," London, 1918, p. 17. The geological history of the bacteria is of course an uncertain matter, depending chiefly upon the inference that various rocks were deposited by bacterial action; the literature on this subject is referred to by Adami (*op. cit.*).

TABLE II.

**(Blank spaces indicate that the presence or absence of the amino-acid was not determined).**

| | Caseinogen. | (3). Noctiluca. | (4). Aspergillus niger. | (5). Tubercle bacillus. | (5) Mycobacterium lacticola perrugosum. | (6). Diphtheria bacillus. | (7). Water bacillus. | (8). Azotobacter chroococcum. | Yeast (3). | Yeast (10). | Yeast (11). |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ilycine (*a*) .. | o | + | + | | | | | | | + | o |
| lanine .. .. | + | + | + | | | | | | + | + | o |
| 'aline .. .. | + | | | + | + | + | | | | + | + |
| eucine .. .. | + | + | + | | | + | | | | + | + |
| ıoleucine . .. | | | | | | + | | | | | |
| henyl alanine. | + | | | + | + | | | | | + | + |
| yrosine .. .. | + | + | | | | + | + | | | + | |
| erine .. .. | + | | | | | | | | | ? | ? |
| ystine .. .. | + | | | o | o | o | o | o | | ? | |
| spartic acid .. | + | + | + | | | | | | o | + | |
| lutamic acid . | + | | + | | | | | | o | + | + |
| ryptophan .. | + | | | + | | + | + | | + | + | |
| roline .. .. | + | + | | + | + | + | + | | | + | + |
| xyproline .. | + | | | | | | | | | | |
| rginine .. .. | + | + | | + | + | + | + | + | | | |
| Lysine .. .. | + | + | | + | + | + | + | + | | | |
| Histidine.. .. | + | + | | + | + | + | + | + | | | |

(*a*) Glycine is present in other mammalian proteins.

may have been chosen because of their suitability, not only for the formation of proteins, but for the production of other compounds as well. Thus arginine and histidine may serve as sources of *purines* (12); *proline is* closely related to a group present in chlorophyll and hæmoglobin; and tyrosine to adrenalin and perhaps some pigments. *One does not of course suggest that the earliest* organisms provided for the future formation of substances such as chlorophyll and adrenalin; but the various chemical possibilities of *these amino-acids may be utilised* by the simplest plants in their metabolism in ways which we do not know of. Pringsheim (17) has considered this point in the case of *yeast*.

There is obviously much to be learned as to the experimental methods by which organisms arrive at the production of suitable substances, *for any given new compound cannot* be brought into existence gradually. The final, or rather the present, product is in many cases a highly successful one (*e.g.*, *the superiority of adrenalin to many allied* compounds (13); the great potency of snake venom), but the preceding stages are effaced by natural selection. *Very little seems to be known also of the method of* synthesis of the amino-acids in plants; possibly the plant makes from dextrose those members of the series which the mammal *can convert into dextrose*.

It has long been taught that animals are dependent ultimately upon plants for their supply of protein. Knoop (15) and Embden and Schmitz (17) and their fellow workers (18, 19) showed however, in some experiments which attracted a great deal of attention at the time (1910), that mammals have some power of synthesising amino-acids. *But surely these experiments, striking as* they are, reveal chiefly the feebleness of this synthetic power in animals; they seem rather to emphasise how *completely parasitic upon the plant the animal has* become. It was shown that the mammal, when supplied with certain α-keto-acids, could convert them into the *corresponding α-amino-acids whether these were of natural* occurrence (alanin, phenyl-alanin, tyrosin, α-amino caproic acid) or not (α-amino-butyric acid, γ-phenyl-α-amino-*butyric acid*). *But this insertion of an* $-NH_2$ *group is no* great synthetic achievement. Firstly, as Knoop points out, this change in keto acids may occur in vitro simply in *the presence of ammonium carbonate*. Secondly, there was admittedly nothing in the experiments to show that the mammal could itself provide the essential molecule to which the $-NH_2$ *group was to be attached*, except the very simple one (that of pyruvic or lactic acid) required for the production of alanin. It is known further that mammals can produce the simplest amino-acid glycin; but whether by a synthetic process or otherwise is not clear (20). Tyrosine can be formed in the liver under experimental conditions from phenyl-alanine (14), and hence appears not to be an essential constituent of diet (15). Whether phenyl-alanine can be synthesised has not yet been shown. This appears to be all the evidence

which we have for the synthesis of amino-acids by mammals.

On the other hand, tryptophan (21), lysine (22), arginine and histidine (12), and apparently cystine (23) cannot be synthesised by the higher animals. Van Slyke (24) has laid stress on the fact that we have no evidence either for or against their power of synthesising any one of the remaining amino-acids, at least ten in number, other than those mentioned above. But it is obvious, from their inability to live upon the simple materials which suffice for plants, that their synthetic powers are at least immensely inferior. The work of Abderhalden and Rona (4) and of Tamura (5), alluded to in Table II., provides an illustration of this familiar fact. In their experiments, *Aspergillus niger* grew equally well, and formed the same amino-acids, whether its nitrogen were supplied in the form of potassium nitrate, or of glycin, or of glutamic acid, and the protein of mycobacterium showed the same composition whether the medium were peptone-bouillon, or one containing no nitrogenous compounds but ammonium lactate and asparagin. No higher animal can do anything of this sort. The fact that no amino-acid which enters into the composition of proteins has been shown to be peculiar to animals has perhaps hardly received sufficient attention; it alone would demonstrate that their synthetic activities in this field, whatever they may be, are nowhere more extensive than those of plants.

Though the matter is a very familiar one, it is perhaps worth while to consider here for a moment the chemical powers of yeast. In the time taken by a yeast cell to produce another by budding* when growing on a medium such as Pasteur's, containing no nitrogen but that of ammonium tartrate, it must synthesise each one of the amino-acids given for yeast in Table II., and combine them as a series of polypeptides until its proteins are produced, and all the while carry on many other chemical operations. Even when one takes into account the small size of molecules it is wonderful that so many reactions can be kept apart within the compass of a yeast cell. One may compare with the obvious growth of yeast the amount of experimental procedure required to bring to light the partial synthesis of a single amino-acid in a mammal and realise what has been lost in the course of evolution. Specialisation is largely a process of loss of capacities; some zoological teaching has perhaps represented it too largely as a progressive development.†

Since the higher animals cannot synthesise some of the amino-acids which are essential to their life the plant world has so to speak a power of blockade over them. If the predominant vegetation of the world entered upon a phase of evolution in which it provided but an inadequate supply of one of these amino-acids, animals would have to adapt themselves to this, though man could of course circumvent any such change by cultivation. It is conceivable that this has happened in the past; thus during the close of the Secondary Period an astonishingly diverse and abundant fauna of reptiles of great size passed out of existence, and it is difficult to believe that the competition of other animals was sufficiently formidable to bring this about.

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* On a wort medium at 28° C. this time is about six hours (Lafar, "Technical Mycology," ii., p. 226), but the rate is considerably slower on the simpler artificial media containing only one or two nitrogenous compounds (77).

† A very interesting discussion of this point is given in "Arboreal Man," by Prof. Wood-Jones (1916, chap. vii. and xxiii.)

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## THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ.

(Continued from p. 4).

*Analysis of the Deposit from the Double Fluoride.*

A deposit, silver-white in appearance, was obtained by electrolysis, of a solution of the double potassium uranyl fluoride solution with a pressure of 4 volts and a normal density of 0·485 amp. This was analysed for its uranium content by heating the electrode until the white deposit had changed to a golden-yellow oxide, after which the deposit was dissolved in nitric acid. The uranium was determined by precipitation from the uranyl nitrate solution with ammonia.

TABLE II.

| | Sample 1. | Sample 2. | Sample 3. |
|---|---|---|---|
| Weight of deposit (grm.) .. | 0·0522 | 0·0494 | 0·1457 |
| $U_3O_8$ found (grm.) .. .. | 0·0374 | 0·0362 | 0·1014 |
| Weight of uranium (grm.) .. | 0·0313 | 0·0303 | 0·0818 |
| Per cent U .. .. .. .. | 57·50 | 61·45 | 56·20 |

Sample 2 was not the clear white deposit obtained before, but showed contamination with the black oxide above mentioned. Samdle 3, obtained from a fresh solution of the double salt, was white. It was obtained with a voltage of 4 and a current density of 1·63 amp.

The similarity of the behaviour of the white deposit, when heated, to the behaviour of uranium tetrafluoride when it was heated, suggested that the deposit might be a fluoride of uranium. This was proven to be correct as the following analysis shows:—Tests for fluorine were made by placing one of the electrodes in a large platinum dish, adding concentrated sulphuric acid, and covering the dish with a glass plate coated with paraffin. The design drawn in the paraffin was not etched in any case though,

* From the *Journal of Physical Chemistry*, xxiii., No. 8.

several tests were made in this way. After failing to find fluorine in this manner an analysis for fluorine was made on a newly prepared deposit.

*Method of Analysis.*

A mixture of sodium and potassium carbonates in such proportion as to give the lowest fusing mixture possible were brought to a quiet fusion in a platinum dish. The electrode with its deposit was then dipped into the fused mass, and rotated until the electrode was coated with the fusion material. The temperature was then raised, and the heating continued until the electrode showed a smooth coat of the fused carbonates. The melt was taken up with water and carefully acidified with dilute nitric acid until just neutral or slightly basic. A large portion of the carbon dioxide was removed in this way. The slightly basic solution was then heated to boiling for a short time and allowed to cool. A slight excess of nitric acid was then added and the solution was again made alkaline with a slight excess of ammonia. On boiling the solution several minutes the remaining carbon dioxide was driven off as ammonium carbonate. At the same time the uranium was precipitated as ammonium uranate. This was filtered off and the fluorine in the filtrate was then determined by precipitation from a neutral solution as calcium fluoride.

TABLE III.

| | Sample 1. | Sample 2. |
|---|---|---|
| Voltage | 3 | 3 |
| N.D.100 | 1·63 | 1·63 |
| Weight of deposit (grm.) | 0·2444 | 0·1076 |
| Weight of $U_3O_8$ (grm.) | 0·0880 | 0·0736 |
| Per cent U | 57·70 | 53·40 |
| Weight of $CaF_2$ (grm.) | 0·0404 | — |
| Per cent F | 16·05 | — |

The varying results in the uranium content given in Tables II. and III. would indicate that the deposit was not always uniform. The fluorine result in Sample 2 was lost through breakage. The amount of fluorine found in Sample 1 is very close to the theoretical amount required to form $UF_4$ with the uranium present. Taking the difference between 100 and the per cent of uranium and fluorine as water, the empirical formula for the deposit would be $UF_4 6H_2O$. The water was not determined quantitatively directly, but its presence was proven qualitatively. The fluorine was proven to be present by testing the precipitate formed with calcium for fluorine.

The white deposit formed when an aqueous solution of potassium uranyl fluoride is electrolysed, whether in neutral or acid solution, is insoluble uranous fluoride. The uranium is evidently deposited upon the cathode as $UO_3$ and immediately converted to the fluoride by the hydrofluoric acid present. No metallic uranium is obtained by the electrolysis of the double potassium uranyl fluoride.

The potential of the uranyl fluoride deposit is −0·389 volt. Whenever the deposit was blackened the potential found was the same as that of the black deposit obtained from aqueous solutions of uranyl nitrate and uranyl oxalate.

9. *Electrolysis of Potassium Uranyl Fluoride in Ammoniacal Solution.*

It was found that ammonium hydroxide would not precipitate uranium from aqueous uranyl solutions in the presence of hydroxylamine. The deposition of uranium from alkaline solution was tried with no results. The deposits formed were the colour of bronze with a fringe of green. A larger deposit could be obtained in a shorter time than was possible in acid solution, and this deposit contained a larger per cent of uranium. The composition of the deposit was not constant as shown by analysis.

TABLE IV.

| | Sample 1. | Sample 2. | Sample 3. |
|---|---|---|---|
| Weight of deposit (grm.) | 0·3046 | 0·1975 | 0·1386 |
| Weight of $U_3O_8$ | 0·2237 | 0·1508 | 0·1142 |
| Weight of uranium | 0·1878 | 0·1264 | 0·0958 |
| Per cent of uranium | 61·55 | 64·50 | 69·20 |

The deposits were obtained by electrolysing the solution with a pressure of 4 volts and an average current density of 1·8 amp. Stationary electrodes were used and the container rotated. The single potentials of these deposits were not measured.

10. *Electrolysis of Fused Potassium Sodium Uranate.*

A fused bath of potassium sodium uranate was prepared by fusing a mixture of potassium and sodium carbonate in a nickel crucible and adding the green uranium oxide to the melt. This dissolved in the carbonates with evolution of carbon dioxide and formed a molten mass. The first attempt was made with platinum electrodes. The fused material was electrolysed under a pressure of 3 volts and a current density approximately 33 amp. The alkali metals, which separated out along with the uranium at the cathode, burned near the surface of the melt. The platinum was attacked by the burning alkalis, and almost eaten through at the surface of the melt. The portion below the melt was not injured quite so much, but became brittle and broke up when the electrode was removed. The electrode was washed first with cold water and finally with dilute acetic acid. The platinum that was below the surface of the melt was grey and would not clear up in treating with concentrated nitric acid. When heated on the lid of a platinum crucible the grey coat became green and could then be dissolved off with nitric acid. Qualitative test indicated that metallic uranium had actually been deposited on the platinum. The black powder that had washed off the electrode with water was uranium oxide.

Electrolysis of a similar bath with nickel electrodes gave a black powder around the cathode. This was insoluble in water and in acetic acid and was difficultly soluble in dilute nitric acid. From its behaviour toward nitric acid it appears to be powdered metallic uranium mixed with some black uranium oxide. The nickel electrode contained no deposit of uranium with which a potential reading could be taken, nor was it possible to make an analysis of the small amount of the black powder obtained.

(To be continued).

## THE ALLOYS OF COPPER AND SILICON.*

By M. A. SANFOURCHE.

THE alloys of the copper-silicon series have been studied by a large number of investigators, who have indicated certain definite chemical compounds formed by the two elements (see Baraduc-Muller, *Revue de Métallurgie*, 1910). The more recent work attempts to prove the non-existence of certain of these compounds. Rudolfi in his diagram does not show any compounds other than $SiCu_3$ and $Si_4Cu_{19}$. This latter compound is indicated as being formed by reactions occurring in the solid alloys.

A provisional solidification diagram has already been described by the present author in conjunction with M. Vigouroux (*Revue de Métallurgie*, 1912). The work has now been completed, and the complete diagram, including the transformations in the solid state, is now described.

The purity of the materials used in the investigation is discussed. For microscopic examination it was found that an etching with $HNO_3$ followed by a very light polishing served to show up the harder constituents in relief. Several

* *Revue de Métallurgie*, July-August, 1919.

specimens were examined after treating with a boiling potash solution. The action of this reagent was not very strong, but it was found to hasten the differential colouring of the constituents, which otherwise was found to take many days' exposure to the atmosphere to take the red or iridescent colour necessary for examination by this method. The diagram is then described. In the first portion of the diagram from 0·0 to 8·60 per cent silicon two series of solid solutions are found, which are designated alpha and beta. The alpha range extends to a concentration of 7·58 per cent silicon and the beta range from 7·58 to 8·60 per cent silicon.

Another series of solid solutions are formed at the 7·58 per cent concentration by reaction between the alpha solution already deposited and the mother liquid. This series is denoted as *b*. The alpha solid solutions do not exhibit transformations after solidification.

The beta solid solutions undergo two successive transformations, as follows:—(1) A transformation designated $C_1$ marked by a slight retardation in the rate of cooling or heating at a temperature of 774° C. in the 8·50 per cent alloy. The transformation indicates the appearance of a new phase, $\beta^1$, of the $\beta$ crystals. (2) An analogous transformation, $C_2$, during which the $\beta^1$ crystals are transformed into a new form, $\beta^2$, at a temperature of 728° C. The temperature of the transformation is but little influenced by the variation in composition of $\beta^1$.

In the second portion of the diagram from 8·60 per cent to 12·10 per cent silicon a eutectic point occurs with a concentration of 10 per cent silicon at a temperature of 815° C. Two new series of solid solutions are formed designated respectively $\gamma$ and $\delta$. The series show a maximum at 12·10 per cent silicon at a temperature of 853° C. Both these solid solutions undergo transformations in the solid state.

All the alloys containing more than 12·10 per cent silicon are subject after a time to spontaneous alteration, which is accompanied by an alteration in volume with a tendency to break into fragments. This alteration commences to manifest itself after a period of several months, and would appear to be complete after about one year. It is also more predominant in those alloys richer in silicon.

In concluding, it is considered that there still remains considerable doubt as to whether true chemical compounds exist in the series. The only maximum appearing on the liquidus curves, and to which the formula $Cu_3Si$ was assigned by Rudolfi, is considered to more nearly correspond to the formula $Cu_{19}Si_4$.—*Technical Review*, v., No. 52.

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## THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.*

### Its Objects and Scope.

The Pharmaceutical Society originated seventy-eight years ago by the coming together in London of certain chemists and druggists, who resolved to resist an attack on the rights of chemists to dispense prescriptions and supply medicines, in attempted legislation at the instance of an Association of Apothecaries, of which it was said: "The obvious tendency of the Bill is to depress and ruin, and eventually to extirpate, the compounding chemists and druggists." There was also a constant tendency to put the practice of pharmacy under the control of the medical practitioners. The voluntary association of chemists and druggists determined to resist any such subordination. It was held that pharmacy was a distinct and separate department of the healing art, and, through the efforts of the founders of the Society, its distinctive position and rights and privileges were for the first time put on a clear and independent basis. This was accomplished chiefly through the disinterested efforts of a few leading London pharmacists, of whom Jacob Bell was the most distinguished; but even from the very outset prominent pharmacists in Edinburgh and some other parts of Scotland were included in the membership of the Society, the most conspicuous of these being Mr. John MacKay.

*An Earlier Movement.*

It is of interest to note a similar movement in Edinburgh so far back as 1785, when the Society of Druggist Apothecaries was incorporated. The Articles of Association are signed, among others, by Mr. John Moncrieff, the founder of J. F. Macfarlan and Co., and James Gardner, of Gardner and Ainslie. The former was the son of the Rev. Sir H. Wellwood Moncrieff, of St. Cuthbert's Church, and the latter was the son of the Session Clerk of St. Cuthbert's. That society was established on a basis of education, examination, and registration, but for some reason seems not to have been maintained in full activity. The Royal College of Surgeons of Edinburgh has a charter right to grant a certificate to practise pharmacy, and it was in this connection that a qualification was provided for the membership of the Society of Druggist Apothecaries of 134 years ago. When Jacob Bell came to Edinburgh in 1852 he found a committee in existence in Edinburgh, and James Gardner was able to explain that it represented what remained of the old society of 1785. The articles of association of this society were presented to the North British branch by Mr. James MacKenzie in 1895. It was on the basis of this still existing committee that, when a Board of Examiners for Scotland co-ordinate with the Board of Examiners for England and Wales was established by statute in 1852, the local elected body—now known as the Executive of the North British Branch—was established. While the Board of Examiners was fixed by statute, the Executive of the North British Branch and the maintenance of a Scottish headquarters of the Society under the general control of the Council as the supreme governing body was based on an honourable agreement between Jacob Bell, acting for the Council, and the representatives of Scottish pharmacists, chiefly under the guidance of Mr. John MacKay.

*The Voluntary Basis.*

The Pharmaceutical Society founded in 1841 was a purely voluntary association, ready to do anything and everything likely to secure the recognition of the pharmacist as a distinct and independent craftsman. From the very outset, however, at least three aspects of its work became sufficiently prominent to be distinctly specified—namely (1) education, examination, and registration as a guarantee of professional efficiency; (2) the safeguarding in all necessary ways of the legitimate rights and interests of those carrying on the business of chemists and druggists; and (3) the providing of a fund to relieve distressed members of the society. There is no evidence that these main purposes were intended to be inclusive of all the activities of the Society, nor have they ever been so. The Society has never for a moment hesitated at any time to deal with any matter relating to the profession of a dispensing chemist or germane to the business of a chemist and druggist. The circumstances of the early days, however, made it necessary to lay the emphasis chiefly on education, examination, and registration. These are the centre and core, the very *raison d'être* of pharmacy as a distinct and separate craft. On that solid foundation the stability and success of the superstructure must depend, and if the professional element is ever neglected or eliminated pharmacy as a distinct craft would cease to exist, and the main purpose for which the society was founded would disappear. But the moment men in any craft begin to associate for

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* An Address given by Mr. J. Rutherford Hill, Resident Secretary in Scotland of the Pharmaceutical Society, at a meeting of the Edinburgh Chemists', Assistants', and Apprentices' Association on

diately claim the attention of, and are dealt with by, the persons who have become associated. The experience of the Pharmaceutical Society has resembled all other associations of members of a common craft in this respect.

*Obtaining the Charter.*

The first President of the Society was William Allen, a distinguished London Quaker, who was deeply interested in philanthropic work and was consulted in this connection by Queen Victoria, who held him in high esteem. Through his association with the Queen he was able to secure a Royal Charter of Incorporation for the Pharmaceutical Society in 1843. This gave the Society an enhanced status and high privilege, which entitled it to be regarded as the officially recognised exponent and representative of pharmacy in Great Britain. Naturally the three main objects of the Society were specifically embodied in the Royal Charter, and the means by which these objects and the general business of the Society are to be carried out are specified in detail. Thus arise the Charter rights and powers and duties of the Society, for the due execution of which it was originally answerable to the Crown. In a business so mixed as that of a chemist and druggist there are many questions arising which are common to other classes of business in which similar articles are sold. This danger of diffuseness in operations was present to the mind of Jacob Bell when he said:

"Those who are sincere in the desire for the advancement of our own legitimate profession, which is pure pharmacy, will perceive the importance of confining our attention as much as possible to that pursuit."

It seems quite clear that Jacob Bell's ideal of the Pharmaceutical Society was not a commercial association, but rather an educational and professional and scientific society, and it has always retained these features in an eminent degree.

*The Poison Laws.*

A few years prior to 1851 the occurrence of numerous arsenic poisoning cases caused public alarm and claimed the attention of Parliament. Chemists and druggists urged the limitation of the sale to trained persons, but there was no statutory definition of a chemist and druggist and no official register. Limitation to competent vendors was therefore impracticable, and hence the futile Arsenic Act of 1851. But an issue had been raised which led to legislation at a later date. Meantime the Pharmaceutical Society promoted and secured Parliamentary sanction for the Pharmacy Act of 1852. It has nothing whatever to do with poisons, and seeks to accomplish its purpose by limitation of professional titles to qualified, examined, and registered persons. Its purpose is stated to be "To prevent ignorant and incompetent persons pretending to be pharmacists." The statute is based on the Society's Royal Charter, which it extends and modifies and incorporates in the Act itself. The Charter thereby acquires the force of statute law. By-laws made under the Charter and Pharmacy Act, which must be approved by a principal Secretary of State (altered in 1868 to the Privy Council), after due promulgation, have also the force of statute law. That being so, any question as to interpretation or powers or functions can only be determined by the public judicatories established by Parliament. Some years prior to 1868 much public alarm was caused by a series of lamentable criminal and accidental poisoning fatalities. As usual, Parliament proposed to check the evil by imposing purely mechanical restrictions. The Society strongly insisted that the only safe foundation for poison legislation was the education of the vendor. This principle was ultimately embodied in the Pharmacy Act, 1868. The purpose of that Act is indicated in the words: "It is expedient for the safety of the public that persons known as chemists and druggists should possess a competent practical knowledge of their business." Logically it should have limited, as in Ireland since 1875, the dispensing of medicines to duly qualified pharmacists, but unfortunately chemists and druggists were divided among themselves, and thus the Society's endeavour was frustrated. The Act of 1868, like all the other Pharmacy Acts, starts with the Royal Charter as its basis, and all these extensions and modifications by statute make a reference to the public judicatories the only competent process for its interpretation in a truly authoritative and decisive manner.

*Retrograde Legislation.*

The Poisons and Pharmacy Act, 1908, must be classed as a retrograde measure in so far that it infringes the fundamental principle of the Act of 1868 by permitting unqualified vendors holding a local authority licence to sell certain scheduled poisons on observing certain merely mechanical restrictions. The futility of such a policy was proved in the case of the Arsenic Act, 1851, and it may be said these provisions of the Poisons and Pharmacy Act, 1908, are as much a dead letter as those of the Arsenic Act, 1851. This departure was strenuously opposed by the Society, but very powerful influences in Parliament proved too strong, and the long-continued public security from poisoning resulting from the Act of 1868 had begotten a general public indifference. Apart from this sinister Parliamentary relapse, it may be said that what is intended to be protected is the business of a chemist and druggist in so far as it is safeguarded by the provisions of the Charter and Pharmacy Acts, and that from the point of view primarily of the safety and protection of the public. That is to say, the Charter and the Acts pursuant thereto are designed to protect and regulate those professional restrictions and conditions which are intended to prevent any "ignorant and incompetent person" posing as a chemist and druggist.

*The Business of a Chemist.*

No doubt the Charter and Pharmacy Acts also had in view the statutory acknowledgment and protection of the pharmaceutical practitioner against the attempts of the apothecaries and medical practitioners to prevent chemists and druggists practising as dispensers of physicians' prescriptions and vendors of medicines and simple remedies, and the right of the community to obtain medical supplies without any physician's prescription. This latter point came up very sharply in connection with the Military Service Acts and the exemption of men indispensable for maintaining an adequate pharmaceutical service. An attempt was made to insist that the only national service for which a pharmacist could be exempted was the dispensing of written prescriptions. This contention was strenuously opposed by the Society and defeated. Since 1868 the pharmacist in the statutory sense is a person not limited to the vending of medicines or medical or surgical appliances, but he holds the only statutory British qualification for the dispensing of all medicines and the retail vending of all poisons. The business of a chemist and druggist, in the sense of the Charter and Pharmacy Acts, is therefore very comprehensive. It therefore follows that the Charter powers, functions, and duties of the Pharmaceutical Society, as now defined by Parliament, to whom the Society is responsible through the Privy Council, are very wide and may be summarised as follows:—

1. Education and technical and scientific training. The advancement of chemical and pharmaceutical knowledge by means of schools, lectures, meetings, museums, libraries, books, laboratories, scientific research, endowments, prizes, and scholarships.

2. Professional qualification and registration and the protection of professional titles. This includes reciprocity within the Empire or with foreign States.

3. Professional rights, privileges, and obligations in the dispensing of medicines and in the supply or vending of poisons under the Pharmacy Acts, National Health Insurance Acts, Defence of the Realm Act, Venereal Disease Act, Arsenic Act, Poisoned Flesh Prohibition

Act, Poisoned Grain Prohibition Acts, Drugging of Animals Act, Sale of Intoxicants Regulations, or any other legislative enactment affecting the supply of medicinal substances, or the supply of poisons for domestic, industrial, or technical purposes, or as antiseptic or fungicides, or the vending of potent dangerous chemical substances, or the making, extending, modifying, or cancelling of enactments or Orders in Council bearing on these matters.

4. All conditions, legislative or otherwise, affecting the professional practice of pharmacy in retail pharmacies, in hospitals or dispensaries, or in the Army or Navy or Mercantile Marine. This would include the recognition, representation, and status of pharmacists under the National Health Insurance Acts, and also all questions affecting mobilisation of pharmacists for naval or military duty, and the maintenance of an adequate pharmaceutical service for insured as well as uninsured persons.

5. All questions relating to the supply of medicines or medical or surgical appliances or antiseptics or disinfectants coming within the scope of a Ministry of Public Health. This may be of very vital importance owing to the evident tendency towards the nationalisation of medical and pharmaceutical services.

6. Questions relating to the use of alcohol or other substances for medical purposes and all questions as to Customs and Excise Regulations affecting the practice of pharmacy.

7. Questions relating to the Medicine Stamp Acts, the Explosive Substances Act, or other enactments affecting the supplying, transport, or storage of medicines, or medical or surgical appliances or poisons.

8. Questions relating to the compilation and publication of the British Pharmacopœia, the Sale of Food and Drugs Acts, and all matters relating to the fixing of standards and formulæ for drugs and medicinal preparations. The Society has also to be consulted by Government Departments in framing any regulations affecting the practice of pharmacy or the vending of poisons.

9. The professional rights and privileges of pharmacists in supplying to the public, according to recognised and universal custom, the medicinal substances and appliances in which they deal, and the rights of the public to obtain such medicinal substances and appliances. The Profiteering Act and the Shops Acts may conveniently be included in this section.

10. All other questions relating to the foregoing matters which belong distinctively to the practice of pharmacy or the vending of poisons and the securing of the safety of the public in connection therewith. This would include disciplinary powers over all registered pharmacists.

11. Recognition of the Society as the sole statutory representative of British pharmacy and those engaged in the practice thereof, and qualified to advise the Government and any public authority on all matters relating to the supply and distribution of medicines and medical and surgical appliances and poisons and the dispensing of physicians' prescriptions, and having authority to administer the Pharmaceutical Poisons Acts.

12. All matters relating to the benevolent fund or any other matters distinctly specified in the Charter or Pharmacy Acts or necessary for carrying out any objects so specified.

It will be realised that this summary of matters which clearly come within the objects of the Society as expressed in the Charter and Pharmacy Acts means a very great amount of multifarious duties and responsibilities, constantly requiring the thought and time and labour of the Society's Council and staff. The Charter and Pharmacy Acts make it imperatively necessary that all these matters shall be faithfully attended to. But there are innumerable matters beyond all these which are continuously receiving attention and which occupy a large amount of the time of the Council and the staff. No member of the Society applying for information or help or guidance is ever met with the objection that what he wants is not within the Charter or Pharmacy Acts.

The rest of the paper dealt with the functions of outside bodies, such as the Proprietary Articles Trade Association and the Chemists' Defence Association, and deal specifically with the local organisation of the Pharmaceutical Society in Scotland.—*Chemist and Druggist.*

## PRODUCTION AND EXPORTATION OF MERCURY IN SPAIN.

By Trade Commissioner W. M. STRACHAN, Madrid.

Mercury is produced in the Provinces of Ciudad Real, Granada, and Oviedo, but the most important mines are those of Ciudal Real, which are located at Almaden and cover a surface of 485,187 acres. They are owned and operated by the state.

The Estadistica Minera de España contains some interesting statistics as to the cost of operation of the Almaden mines during the year 1917. In this year excavations were made at 300 sites, at which 2765 cubic metres were excavated at a total labour cost of 97,333 dols. The average daily wage paid was 2.50 dols. The average labour cost per cubic metre was 35.20 dols. The archwork, solid walls, and masonry erected for the interior support of the mines cost, for materials and labour including transportation, timbers used for bracing galleries and shafts, &c., a total of 155,477 dols. Shop expenses for work not let out by contract amounted to 15,931 dols. the various articles classed as accessories cost 81,658 dols., and labour not otherwise specified added 44,498 dols. to the expense.

For labour used in distillation during 1917 the expenditure was 76,132 dols., and for supplies 82,148 dols. Ten pairs of Bustamente sub-liming furnaces, two Cormak-Spirek continuous-movement furnaces for fine materials, and three double-pan furnaces of the same system for coarse ores were employed. In the Bustamente furnaces 7550 tons of mineral were treated, from which were produced 984,486 pounds of mercury. In the Spirek system 688,795 pounds of mercury were produced from 5616 tons of ore.

*Output and Quantities Exported.*—The ore on hand at the beginning of 1918 amounted to 60,225 short tons, and the production during the year was 11,013, making a total of 71,238 tons. Minerals treated during the year totaled 13,166 tons, yielding 911·7 tons of mercury; thus the metal content was 6·93 per cent.

The exports of mercury from Spain for the year 1908 to 1916, inclusive, were—

| Year. | Pounds. |
|---|---|
| 1908 | 2,353,629 |
| 1909 | 3,069 959 |
| 1910 | 2,466 933 |
| 1911 | 3,293,392 |
| 1912 | 2,769,085 |
| 1913 | 2,746,386 |
| 1914 | 2,099 978 |
| 1915 | 2,694,394 |
| 1916 | 1,752,538 |

A comparison of the figures of output and export shows that practically the entire production is exported—chiefly to Great Britain.—*Commerce Reports*, Aug. 18, 1919.

Profiteering Act.—Statements having appeared in the Press to the effect that the publication of the results of investigations under the Profiteering Act will be delayed, it may be stated that a report of the results of an investigation with regard to Quinine, which is now in the hands of the printers, will be available in the course of a few days. Other reports will also be sent to the printers for publication immediately.

## TRADE IN SOUTH CHINA.

SWATOW is a city with a population estimated at about 80,000, and has few local industries, but is of importance as the seaport for a very rich and thickly-populated agricultural district, having an excellent system of communications by means of inland waterways.

In the volume of its trade it comes eighth in the list of Chinese ports, the total for last year amounting to over 50,000,000 Haikwan taels. A remarkable feature of the trade of the port is the great preponderance of imports over exports, the value of the former amounting to almost 75 per cent of the total, and it is generally held that the balance of trade must be redressed by the large sums remitted annually to this district by Chinese settlers in foreign countries.

*Industries.*—There are no large manufacturing establishments in the port itself or in the district for which it serves as the outlet, but various native industries provide employment for a considerable section of the population. One of the principal industries is the manufacture of a very coarse type of paper of which large quantities are shipped to Singapore and Bangkok, and amongst other important trades are sugar-making, oil-crushing, and the preparation of salted vegetables. A sugar-mill was erected here some years ago by a foreign firm, but owing to the growing competition of Formosan and Java sugars it was found impossible to work it, and it has recently been entirely dismantled.

There are two fruit-canning establishments doing a fairly large business, and a proportion of their output is shipped to the Straits Settlements and other countries where Chinese settlers are numerous, but the sanitary conditions existing in these factories are not such as to commend the products to European consumers.

There is also a small sock-knitting factory using American machines operated by steam-power, which, it appears, has proved very successful, especially since the boycot of Japanese goods has been in operation.

*Local Textile Industries.*—The manufacture of cotton cloth on native hand-looms is a thriving industry throughout the district, and, in addition to the coarse cloth known as "Nankeen," yarn-dyed piece-goods of excellent quality are now being produced in considerable quantities. For the coarsest type of cloth the yarns are mainly of Indian origin, the finer counts coming from Shanghai and Japan. A British firm at Swatow has devoted a good deal of attention to this industry, introducing patterns from Japan and the United Kingdom, and suggesting improvements in the method of manufacture, and although the cloths naturally lack the "finish" of Manchester goods, they compare very favourably in every other respect with the foreign product. Originally all the looms came from Japan, but recently they have mostly been manufactured locally at about a tenth of the cost of the imported machines. The cost of manufacture is extremely low, weavers receiving little more than a dollar a month in addition to their food.

The manufacture of filet lace is also a growing industry, and the export, especially to the United States, is increasing.

*Dyes Wanted.*—German dyes are still being used, although stocks must now be extremely low and prices are ten times higher than before the war. American dyes are gradually being introduced, but the Chinese do not appear to regard them with much favour, and the manager of one weaving establishment stated that in order to obtain the desired results he found it necessary to add a proportion of German colours.

In this connection it must be regarded as most regrettable that British manufacturers have as yet made no serious effort to introduce their dyes to the Chinese market. Even if conditions are such that no very considerable quantities of British dyes are yet available for export, it would appear to be highly desirable that sufficient supplies should be furnished to secure some slight footing in this market, and to familiarise Chinese buyers with the British product before the arrival of new stocks of German dyes renders competition still more difficult.

Other local industries are the manufacture of grass-cloth, pewter, a low-grade soap, and coarse glassware.

*Vegetable Oils.*—The extraction of vegetable oils (ground nut, pea, wood, tea, &c.), which are the products of most interest to foreign exporters, is effected entirely by native methods, the common Chinese wooden press operated by driving in a series of wedges being invariably employed. The manager of a British firm, which, besides buying the output of various small Chinese concerns, also produces a considerable quantity of ground-nut oil in its own premises, gave it as his opinion that this very primitive native method was not only the most effective in securing the maximum yield of oil, but was also more economical than any form of mechanical press, the cost of labour being extremly low.

In developing its export business at Swatow the firm above referred to has adopted a policy which deserves the careful consideration of British exporters in other parts of China. They have endeavoured to dispense as far as possible not merely with the services of a compradore, but also with all unnecessary brokers and middlemen, and instead of purchasing their oils in large quantities from dealers established in Swatow, they send Chinese representatives to buy up the output of some of the innumerable small oil presses established in every village and country town.

The system naturally demands special qualifications in the men conducting the business. It involves much additional work and organisation, and is calculated to meet with opposition from various vested interests, but in endeavouring to reach the actual sources of production and to eliminate unnecessary commissions, it would seem to be the most logical method of developing the natural resources of the country, and it also tends to check the practice of adulteration, for which the dealers are mainly responsible.

It is naturally impossible to say how far the system would be applicable to other trades and other localities, but in the particular instance referred to the firm concerned appears to be well satisfied with the success of its experiment.—*Board of Trade Journal.*

## BOARD OF TRADE ANNOUNCEMENT.

### THE NON-FERROUS MINING COMMITTEE.

THE Committee appointed by the Board of Trade to inquire into non-ferrous mining recently adjourned for the vacation, after having examined a number of witnesses on Lead and Zinc Mining. Its meetings were resumed under the Chairmanship of Mr. H. B. Betterton, M.P., on January 6, 1920.

Mines in the Halkyn District of Flintshire were represented by Mr. Noel Humphreys, Managing Director of the East Halkyn Mining Company; Mr. Walter Conway, Secretary of the North Hendre Lead Mining Company; and Mr. J. L. Francis, of the firm of Matthew Francis and Son, Managers of the South Halkyn Mines and Engineers to the Halkyn District Mines Drainage Company. They stated that the mines in the district were now worked down to, or below, the level of the existing drainage tunnel, and they were of the opinion that the completion of the new sea level tunnel was essential if mining was to continue in the district, and that State aid could usefully be given to that end. They favoured pumping at the North Hendre, Llynypandy, and South Halkyn mines, under a scheme, inaugurated and nearly completed during the war with the financial assistance of the Ministry of Munitions, as the tunnel could then be driven from several points of attack to the Iron Shaft in two and a half years; while if it were driven from one

end only it would not be completed for eight or nine years. They were of the opinion that if the mines were drained to this level there was a promising future for the industry in the Halkyn District.

Mr. J. Dodd appeared for the Halkyn District Mines Drainage Company, and explained the plans of that Company for draining the mines. The Ministry of Munitions holds a mortgage on the company's assets in respect of the advances made in connection with the pumping scheme. The Company, if released from this mortgage, proposes to raise capital to proceed with the further driving of the sea-level tunnel.

Mr. Philip Jones, Manager of the Holywell Halkyn Mining and Tunnel Company and Managing Director of the Waen and Lerllyn Mines, Ltd., described the mining operations carried on in the past in the district between Talargoch and Halkyn, and recapitulated the history and financial position of the Holywell Halkyn Tunnel Company. He thought that the Government could most effectually help this district by proceeding with the scheme for the Mid-Flintshire Light Railway by providing cheap electric power from a central station to be erected at Queensferry, and by guaranteeing minimum prices for galena and blende.

Mr. Argall, Managing Director of the Nantymwyn Mine, gave evidence relating to the work done by this Company, and referred to the difficulty placed in the way of further development by the shortage of houses in the district.

Mr. T. Miller, Manager of the Welsh Van Mine, stated the reasons for the stoppage of work that had occurred there, and explained the plans of his company for the future development of the Van, Nantiage, and New Castell mines. He advocated the establishment of a Department of Mines, the revision of mining and mineral laws, and the establishment by the Government of a customs works to smelt home-produced ores.

Mr. R. R. Nancarrow, Manager of the Lisburne Development Syndicate, Ltd., and the Welsh Mines Corporation, Ltd., gave evidence respecting developments proposed to be undertaken by these companies and expressed the opinion that there was a promising future for lead mining in this country. He suggested that State aid should take the form of a bonus of 7s. 6d. a foot on all approved development work and of a minimum price for the products got in relation to the increase in mining costs since 1914. He proposed that such assistance should be given for five years.

Mr. Horace Boot, of the Aberllyn Mines, Ltd., represented the mines of the Conway Valley. He referred to the difficulties caused by high wages and the shortage of labour, and was of the opinion that help should be given to the industry by the guarantee of a market for blende at a reasonable price, by an amendment of the system of royalties in vogue, and by the establishment of a Department of Mines to investigate and remedy the troubles of the mine owners.

Prof. O. T. James, of the University of Manchester, gave the Committee the benefit of the results of the investigations he had recently undertaken for the Geological Survey in the mining district of Cardiganshire and West Montgomeryshire. He expressed the view that new ore bodies could only be opened up in this district by extensive prospecting and development.

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The Prince of Wales has forwarded to the Great Northern Central Hospital a cheque for £405 0s. 2d., being one-third of the proceeds of the display at the Royal Albert Hall of the film of His Royal Highness's Canadian Tour. The exhibition was arranged by the Canadian Pacific Railway Company, who defrayed all the costs of the production and by desire of the Prince devoted the receipts to three hospitals in which His Royal Highness was taking a specially active interest.

# PROCEEDINGS OF SOCIETIES.

## FARADAY SOCIETY.

*Annual General Meeting, December 15, 1919.*

The following Officers and Members of Council were elected to serve for the ensuing year:—

*President*—Sir Robert Hadfield, Bart., F.R.S.

*Vice-Presidents*—W. R. Cooper; Prof. F. G. Donnan, F.R.S.; E. Hatschek; Prof. Alfred W. Porter, F.R.S.; E. W. Rayner.

*Treasurer*—Robert L. Mond, F.R.S.E.

*Council*—Dr. J. Allmand; Dr. H. Burns; Prof. C. H. Desch; Dr. J. A. Harker, O.B.E., F.R.S.; Cosmo Johns; Harold Moore; Prof. J. R. Partington; Dr. W. Rosenhain, F.R.S.; Sir T. Kirke Rose; Dr. George Senter.

*Ordinary Meeting, December 15, 1919.*

Prof. Alfred W. Porter, F.R.S., Vice-President, in the Chair.

The Chairman referred to the loss the Society had sustained by the early death of Dr. H. C. Greenwood, a young Member of great promise, who had been carrying out important work for the Nitrogen Products Committee. A Vote of Condolence was passed to Mrs. Greenwood.

Mr. A. George Tarrant, B.Sc., A.R.C.S., read a paper on "*The Measurement of Physical Properties at High Temperatures.*"

An account is given of experiments made upon refractory materials with a view to measuring certain physical properties at high temperatures, particular attention being paid to thermal expansion, tensile strength, and thermal conductivity.

A very satisfactory apparatus for measuring thermal expansion is described, depending upon the relative expansion of the test substance and the graphite sheath in which the substance is heated.

A spiral furnace and stressing arrangement, suitable for work up to 1800° C., is described, and the results obtained are roughly indicated. Some notes on structural and operational details of the apparatus are given.

An account is given of several attempts to measure thermal conductivities at high temperatures, an electrical method and an accurate thermal method being described, as well as two useful but rough thermoscopic methods. The difficulty of obtaining the full temperature of the specimen is particularly referred to.

Lieut. W. A. Macfadyen, M.C., B.A. (Cambridge), read a paper entitled "*An Aspect of Electrolytic Iron Deposition.*"

The experiments detailed were carried out in seeking the best conditions for obtaining thick hard adherent deposits of iron on steel-mechanism parts which had been machined too much, or worn down in a few places, and thus rendered useless, so as to enable the scrapped parts to be replaced in use after treatment.

A simple solution of ferrous ammonium sulphate in water was used as electrolyte, the only additions being sulphuric acid, and, later, powdered charcoal. In the cold the best deposits were obtained from concentrated solutions made about 0·005 normal with respect to sulphuric acid, the current density being up to 23 amps./sq. ft.

From a solution saturated in the cold, heated to 65° C., and made about 0·02 normal acid, excellent deposits were obtained at current densities of up to some 200 amps.

ft., whilst metallic iron in rather less suitable form was deposited at the higher C.D. obtainable in the laboratory, namely, about 1000 amps./sq. ft.

If iron be deposited direct on to a steel base and the whole subsequently annealed above the $A_3$ point for pure iron, the two become strongly welded together. Subsequent case-hardening is then usually advisable, since the annealed electrolytic iron is very soft.

A paper by Mr. J. GUILFOYLE WILLIAMS, B Sc., A.I C. (Glasgow), on "*The Electrolytic Formation of Perchlorate*," was read in abstract by the Secretary.

It is pointed out that present practice in the electrolytic preparation of perchlorate uses much higher temperature of liquor, and current density, than is given in text-books. Experiments are given showing that the current efficiency of the electrolysis is not considerably affected by liquor temperatures up to 60° C. Production of 1 kilo. $NClO_4$ at this temperature requires only about 3.0 K.W.H. against about 3.6 K.W.H. for normal practice. During normal electrolysis the liquor is alkaline owing to the presence of sodium hypochlorite; if this alkalinity is kept down by the frequent addition of hydrochloric acid the current efficiency of high temperature electrolysis is improved.

Prof. ALFRED W. PORTER, D Sc., F.R S., read a paper on "*The Vapour Pressure of Binary Mixtures*."

In order to remove difficulties in connection with the proof of the Duhem Margules formula for the vapour pressures of binary mixtures a simplified proof is given which makes clear the extent of the usual approximations in each step of the proof.

As an example of the application of this equation the simplest form of the integral obtained by Margules is fitted to the experimental curves of J. Sameshima for acetone-ether mixtures. The fit is almost perfect. Sameshima himself gives an entirely different explanation of the curves depending upon the assumed presence of associated acetone in the mixture—to an amount given by the law of mass action. The chemical interpretation is hardly admissible in view of the fact that no allowance is made for molecular attractions, which must always be present. Margules' simple equation allows for these molecular forces, and it is seen that no auxiliary chemical changes are required.

General curves are given from which the value of the parameter necessary to fit any particular experimental data can be obtained by inspection.

Prof. E. H. CAMPBELL (University of Michigan) presented a paper on "*The Solution Theory of Steel and the Influence of Changes in Carbide Concentration on the Electrical Resistivity*."

Baly's force-field theory is applied to the case of the solid solution of the non-ferrous elements in steel. The fundamental concept of this theory is that every molecule of a solute in solution possesses an electro-magnet field. If the force-fields of any molecules are opened in solution these molecules become "active," and capable of reacting with different forms of energy—for example, producing electrical conductance in an electric field. The resistivity of a solid solution, *e.g.*, steel, is dependent upon the concentration and degree of dissociation of the solutes.

The experimental portion of the paper describes a research on the influence of the decarburisation by means of hydrogen of a series of alloy steels on the electrical resistivity when the metal is in both the annealed and hardened condition. Annealed steels containing considerable amounts of chromium, tungsten, and molybdenum show on decarburisation a marked increase in resistivity, due to the removal of the carbon from complex carbides and the dissolution of the metals in the iron. The measurements tabulated indicate marked differences in the constitution of the carbides in the various steels.

# NOTES.

ROYAL INSTITUTION.—On Tuesday next, January 13, at three o'clock, Sir John Cadman delivers the first of two lectures at the Royal Institution on (1) "Modern Development of the Miner's Safety Lamp." (2) "Petroleum and the War." On Thursday, January 15, Dr. R. R. Terry, Organist of Westminster Cathedral, begins a course of three lectures, with musical illustrations, on "Renaissance Music in Italy and England," and on Saturday, January 17, Mr Alfred Noyes gives the first of two lectures on (1) "The Anglo-American Bond of Literature." (2) "Aspects of Modern Poetry." The Friday evening discourse on January 16 at nine o'clock, will be delivered by Sir James Dewar on "Low Temperature Studies," and on January 23 by the Hon. Sir Charles Parsons on "Researches at High Pressures and Temperatures."

A LIVE ORGANISATION.—"I believe that when we are able to place present-day occurrences in their proper perspective it will be acknowledged that the work of the Industrial League and Council in bringing together employers and workpeople—shop stewards and men of the most varied opinions—has done something to sink the asperities of the industrial situation, and helped to create an atmosphere conducive to the consideration of the abstruse and difficult problems which emerge in these times." It is with these words that the Right Hon. G H. Roberts, M.P., Minister of Food, sums up the activities of the Industrial League and Council, which has its headquarters at 66, Victoria Street, London, S.W. 1, and if the December issue of the *Journal* published by that organisation, which has been submitted to us for review, can be taken as any criterion then this eulogium from one of England's prominent Ministers can indeed be regarded in no sense as a passing need of approbation but accorded with a full sense of his responsibilities as one entrusted with the guidance of the future destinies of this country, and, as such, is praise with which we should like to associate ourselves. No finer idea could any organisation have than that which animates the members of this rapidly growing important and influential body. Young in years, but old in knowledge and wisdom, embracing as it does among its members all the pioneers of Great Britain's industries and leaders of Trade Unionism, it has within the short space of five years accomplished much, but for the future no limitations can obscure its horizon. Certainly its official *Journal* can be regarded as a triumph for such a publication, and it is pleasing to note that with its evolution from childhood to sprightly youth the Executive Committee of the League and Council has decided to publish the *Journal* monthly instead of quarterly as heretofore, as there is no doubt that such a *Journal* can do ought else than become a power in the dissemination of intelligence which must be of inestimable value to both employers and employed. The December issue of the *Journal* contains full reports of striking speeches dealing with important industrial problems by Viscount Burnham, C.H., Sir Auckland Geddes, K.C.B., M P., the Right Hon. J H. Thomas, M.P., the Right Hon. G. H. Roberts, M.P., Mr. G. J. Wardle, M.P., and Mr. R. Tootill, C.B.E., M.P.

WE have received from the Comptroller-General of Overseas Trade the "Report on the Conditions and Prospects of British Trade in India." The report has been compiled by Mr. T. M. Ainscough, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon The aim of the report is to impress upon British manufacturers and exporters the recent important and far-reaching changes in the import trade of India, which call for special efforts and revived methods and organisation on the part of British traders. The Report, which is the first prepared by a Trade Commissioner in India, is divided into five parts, the first of which contains a general survey of the industrial and commercial position obtaining

in India immediately prior to and during the war, with particular regard to foreign competition, the development of Indian industries, the attitude of the merchant houses, and the question of manufacturers' branches in India. A *detailed examination of the leading import trades, with* special reference to the changes in character, volume, and origin of import during the years of war, will be found in the second part; while the third part embodies a review of the methods of representation and distribution in India in particular trades, together with definite recommendations as to the revised methods which might with advantage be adopted by British interests in order to meet the now conditions. The fourth part of the Report treats of the development of Indian industries and its significance, with special reference, firstly, to the opportunities for the employment of British capital and industrial management in the country, and, secondly, to the readjustments which will probably be necessary in some of our export trades as the result of the competition of local industries. Mr. Ainscough, as representative of the Government of the *Dominion of Canada in India, analyses in a further* part the prospects for the sale of Canadian produce and manufactures in India. The Report contains valuable information regarding the economic position in India, and it is hoped that publicity will be given to its contents.

Coal Mining in India.—Quite a large number of Committees are now sitting in Delhi to consider questions affecting the expansion of industries in India. These are Committees on Coal Production, Purchase of Stores, Sugar Production, and Chemical Services. Meanwhile a summary of a report by Mr. Trehearne Rees, of Messrs. Forster, Brown, and Rees, London, to the Secretary of State, on "Indian Collieries" has been issued here. In the course of his report Mr. Rees stated that one third of the coal in Indian coal mines is at present being lost by bad methods of mining, while three-quarters of a million tons are lost annually by the wasteful power working of collieries. The proposals contained in the report include the filling in of old workings to enable more complete extraction of coal, large organised schemes for improving conditions of labour so as to settle non-fluctuating labour populations near the mines, central electric power generation an a compulsory non-profit basis, modern cooking and utilisation of by-products, colliery owned sidings and light railways, and briquette manufacturing. Regarding the Assam collieries, Mr. Rees suggests methods for overcoming the sulphuric acid difficulty. He understands that a committee, including those directly interested, will be formed to consider proposals for dealing with the subject after consideration of the report.—*Reuter's Trade Service.*

Canadian Industries Exhibition.—An Exhibition exclusively devoted to Canadian Industrial enterprises, to be held in June next in London, will be one of the most interesting and important of all the series of Exhibitions held during 1920. The Exhibition has the support of the Canadian Trade Commission, the Canadian Manufacturers Association, and the Canadian Mission in London. The organisation is in the hands of Mr. H. Greville Montgomery, Promoter of the Building Trades and other successful Exhibitions, who, in company with Mr. Lloyd Harris, of the Canadian Mission in London, recently paid a visit to Canada to personally enlist the support of firms particularly interested in promoting Canadian interests in the World's markets. Already most of the ground floor space at the Royal Agricultural Hall has been definitely allotted to leading firms, the exhibits comprising Grain Elevators, Separators, Pianos, Woodworking Machinery, Tractors, Confectionery, Polishes, Ready made Houses, Furs, Hardware, Steel Products, &c. All information can be obtained from the offices of the Exhibition, 43, Essex Street, Strand, W.C. 2.

A First Edition of eight thousand copies of the Official Directory of the Association of British Chemical Manufacturers has been [illegible] ready for publication. The Directory is printed in seven languages, Enlish, French, Italian, Spanish, Portuguese, Russian, and Japanese, and is thoroughly and carefully indexed. It contains a complete List of the Members, together with *their Business and Telegraphic Addresses, Telephone* Number, and Codes used. It also contains classified Lists of Chemicals manufactured by each firm. This publication will be of great value to Traders—both Home and Overseas—who desire to purchase Chemicals from British Manufacturers, and will enable them to communicate direct with the manufacturer of any particular chemical product in which they are interested. The price per copy is 10s. 6d. One or more copies will be forwarded, post free, on receipt of remittance by the Association of British Chemical Manufacturers, 166, Piccadilly, W. 1.

Messrs. Jordan and Sons, Ltd., Company Registration Agents, of 116-117, Chancery Lane, have published a report of the companies registered during the half year just ended, from which it appears that very great activity prevails in the country's trade. It is safe to say that in number of companies and amount of capital the past year will have outstripped all its predecessors. The registrations in the United Kingdom for the second half of the year numbered nearly six thousand, with a capital of about £260,000,000. This huge total is contributed to in nearly equal volume by Public Companies (£135,000,000) and Private (£125,000,000). Taken in classes, Textiles and Clothing represent thirty millions—a not surprising total in view of the fact that most fabrics now sell at four times their pre-war prices—Mines twenty-four millions, Shipping over twenty-two millions, Banks and Finance nearly twenty-two, and Oil over twenty millions. Motors figure for over eighteen millions, Carriers for nearly five millions, and Engineers for thirteen millions. Food requires fourteen millions, while Drink is satisfied with less than two. Insurance accounts for nearly ten millions, Kinemas for over six. In contrast to these considerable figures, our Educationists may feel disappointed that Schools can show but a paltry £66,500, while Sports attract £575,000. Music does not play a prominent part in London, while in Edinburgh and Dublin it does not play at all. Patent Remedies, too, find no place in the latter capitals, while in London they do not appear to be in great request. Aircraft do not yet seem to have attained popularity with the Company Promoter, and Undertakers and Cemeteries remain unattractive.

## MEETINGS FOR THE WEEK.

*Monday, January 12.*

*Royal Geographical Society, 5.*

*Tuesday, January 13.*

Royal Institution, 3. "Modern Development of the Miners' Safety Lamp," by Sir John Cadman.

Royal Photographic Society and the Röntgen Society, 7.

*Wednesday, January 14.*

Royal Society of Arts, 3. (Juvenile Lectures). "Railways and Engines," by L. Pendred.

Faraday Society, 4.30 and 8. (In co-operation with other Societies, at the Royal Society, Burlington House). Symposium and General Discussion on "The Microscope—its Design, Construction, and Applications.

*Thursday, January 15.*

Royal Institution, 3. "Renaissance Music in Italy and England," by Richard R. Terry.

Royal Society of Arts, 4.30. (Indian Section).

Chemical Society, 8.

*Friday, January 16.*

Royal Institution, 9. "Low Temperature Studies," by Sir James Dewar.

*Saturday, January 17.*

Royal Institution, 3. "Anglo-American Bond of Literature," by Alfred Noyes.

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## USE OF ELECTRICITY IN AGRICULTURE.*

WITH SPECIAL REFERENCE TO ITS DEVELOPMENT IN GERMANY.

By JOHN FRANCIS CROWLEY, D Sc, B A, M.I E.E.

(Continued from cxix., p. 276).

*Double Winder Ploughing* (continued).

A NUMBER of actual experiments were made in the year 1909 and the spring of 1910 to determine the motor capacities required for the Double Winder Ploughing system. According to these observations 14-16 kw. hours were consumed in ploughing 2500 square metres, *i.e.*, nearly two thirds of an acre, to a depth of 20 25 centimetres in moderately heavy ground. When the resistance of the ground became greater, due to rain, 18-20 kw. hours were required, and the highest figures observed on the heaviest ground were from 22-24 kw. hours when the depth of furrow was 37-44 centimetres. The tests were carried out with a five-share reversible plough of 2·2 metres working width. The full capacity of the plough depends on local conditions, and on trials with a plough of the size referred to it was found that with a moderate winding speed of 1 65 metres per second and a furrow length of only about 400 metres, two acres could be ploughed per hour to a full depth of about 16 in. Similar trials with a three-share plough with an average speed of 1·6 metres per second and with a comparatively disadvantageous furrow length of only about 300 metres showed that a surface of 1½ acres could be ploughed in one hour to a furrow depth of about 16 in. On the basis of these results and a working day of fourteen hours, which is the usual length of a Continental working day in the principal ploughing months, and taking into consideration the delays for changing the transformer wagon, &c., about 23 acres could be ploughed daily, a feat which has been actually accomplished on several estates. It is not possible, of course, to plough every day at the same rate without stopping. In unfavourable weather, and on account of other circumstances, one or other winding wagon may not be moved forward as quickly as is necessary to maintain the above output, and other delays may occur when the connecting cable has to be lengthened or the transformer wagon moved to the nearest connecting point, which has to be done usually about once a day, but in any case the average daily capacity should not be less than 19-20 acres.

As only one winding wagon is employed at the one time in the double winder ploughing system, while the motor of the other winding wagon is at rest during this pull, a smaller motor may be employed on this system than in the single winder system for a similar ploughing output. By this means, and by dispensing with one drum and the corresponding plough rope, the total weight of the winding wagon is reduced, or, in other words, for an equal working weight of motor the capacity of the double winder plough is greater than that of the single winder plough.

Four workers only are necessary for working the whole double winder ploughing system, viz., two winding wagon attendants and an attendant for the reversible plough, with an ordinary labourer to assist the latter.

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Among the advantages of the double winder system may be mentioned the following:—

1. The extremely simple working of the whole plough set.
2. Its suitability for large fields.
3. Great surface capacity on the heaviest ground with deep furrows, and with small consumption of current.
4. The possibility of fixing the winding wagons on very sloping ground, which is not possible in the case of steam ploughs.
5. Smaller wear of wire cable than in the single winder system, because only one wire length is required to cross the field.

*Single Winder Ploughing.*—A complete equipment for single winder ploughing consists of (*a*) a winding wagon; (*b*) an anchorage wagon; (*c*) the haulage cable.

(*a*) The winding wagon for single winder ploughing carries the electric motor with its control apparatus, the gearing, and the haulage cable drums. The weight of a wagon without wire cable or electric cable is about 13,500 kgrms. (13·3 tons), and the wagon is designed for a maximum pull of 4000 kgrms. (3 9 tons). Some dimensions of this wagon are given in the following table:—

| | Length. Metres. | Width Metres. | Height. Metres. |
|---|---|---|---|
| Overall dimensions .. | 6·4 | 2·6 | 3·5 |
| Wheels, front .. .. | — | 0·33 | 1·3 |
| Wheels, back .. .. | — | 0 5 | 2·3 |

The wheels are of ample dimensions to suit farming operations, and permit of safe and easy movement of the winding wagon even on soft wet ground, and also to provide the necessary stability. The electric motor is of the standard rainproof type, and the entire wagon is protected by a roof, the sides being open to give an unobstructed view, which is necessary with this system. A locked protecting cover can be provided for the driving gear, and when this is fitted a standard plain type motor may be used. The size of the winding wagon is such that motors of from 60 90 h.p. output can be used, and a ploughing set has recently been put on the market fitted with a motor of an output of 40 h.p. The power is transmitted, as in the case of the double winder wagon, from the motor shaft to the gearing by means of pulleys and belts, and the remarks made as to electrical and mechanical control gear and safety devices, the advantages of belt drive, &c., in describing the double winder wagon apply here also. Generally, the construction of the winding wagon for the single winding wagon system is similar to that for the double winding wagon system, but the mechanical gear for the single winding system is more complicated, since two cable drums are in use, the direction of rotation of which must be alternately changed. In the type of wagons described, the toothed gear-wheels, rope drums, and main bearing housings are made of the best cast steel, and the shaft and axles of Siemens-Martin steel. The change-over two-speed gear enables the reversible plough to be hauled either at the moderate speed of 1·1 or 1 6 metres per second without changing the gear wheels. With the same gear ratios the speed of the winding wagon itself can be 2·1 or 1·5 kilometres per hour respectively. These speeds are generally adopted, but, if necessary, by changing the pulleys the speeds can be altered within certain limits. The possibility of changing the speed of the haulage drum during work is of special advantage when the wagon is used for hauling turnip cutters or ploughing much neglected land. A number of clearly printed name-plates show the driver the purpose of the different levers, so that an intelligent farm hand, after a short period of instruction, should be able to drive the wagon, thus doing away with the necessity for skilled attendants.

(*b*) The anchorage wagon or winch used in the single winder system is illustrated in Fig. 10. It consists of a framework which carries the drums and pulleys with their gearing, the whole being supported on four wheels having

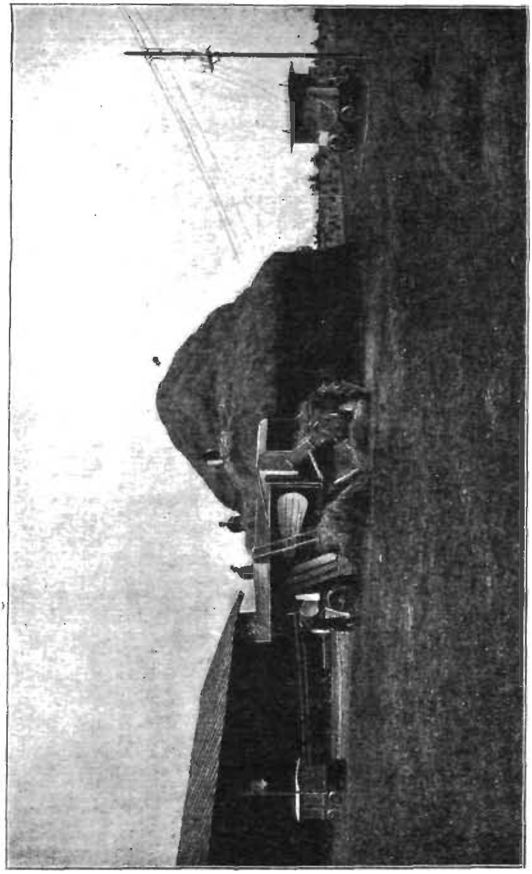

Fig. 1.—Threshing by Electricity.
High-tension Overhead Line with Switch and Connecting to Transformer Wagon (on the right) with Low-tension Cable connecting to Motor Wagon (on the left).

deep stability flanges. Its total weight is about 4000 kilogrms. (3.9 tons). In addition to the removable stability flanges on the running wheels, it is also provided with extra so called anchorage flanges, the distinguishing feature of which is that the stability of the wagon increases as the pull on the plough haulage cable increases. The additional anchorage flanges are carried from the wagon framework on the movable frame between the wheels, which is so connected with the cable haulage pulley that the anchorage flanges are forced either perpendicularly or obliquely deeper into the ground as the pull on the haulage cable increases, thereby obtaining a firmer hold on the soil. These flanges have the great advantage that by their use the movement or tilting of the anchorage wagon towards the plough is reduced to a minimum. This is the case because the flanges are

ocked during ploughing, and include the period during which the anchorage wagon is moved forward. The flange surface embedded in the ground bears a fixed ratio to the pull on the cable, and the movement of the anchorage wagon towards the plough is avoided. The anchorage flanges can be put in or out of action by lowering or raising their movable framework, and the stability flanges on the running wheels are so arranged that they can be quickly and conveniently taken off, thus enabling the anchorage wagon to be easily moved along roads.

being obliged to reverse any gear. No skilled labour should, therefore, be necessary to supervise the anchorage wagon, and the distance it has to be moved forward is always adjusted beforehand to suit the effective width of the reversible plough and the length of the furrow.

Four workers should be sufficient to attend to an entire single winder ploughing set, viz., a winder wagon driver, a reversible plough driver, an ordinary labourer to help the latter, and one for the anchorage wagon. The surface capacity of the Single Winder Plough depends entirely on the capacity of the motor, the number, width, and

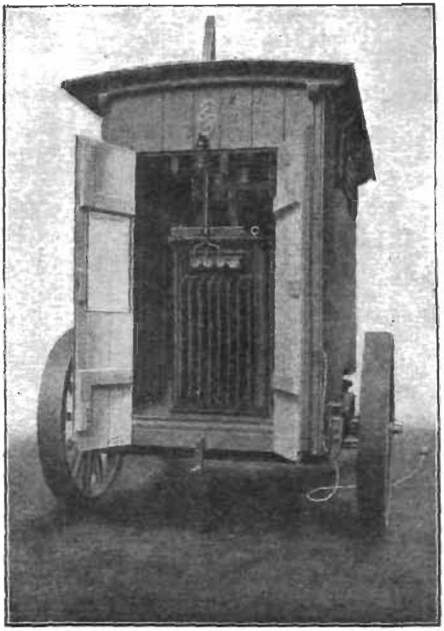

FIG. 2.—TRANSFORMER WAGON.
High-tension Compartment Open, showing Three-phase Transformer, 15000/1000 Volts and 15000/380 Volts.

When the anchorage wagon is at work, it has fastened to it a special steel cable about 130 150 metres long, the far end of which is fixed in the ground. The object of this steel cable is to cause the anchorage wagon to move forward in a direction at right angles to the lengths of the furrow by double the total working width of the ploughshares during the period that the plough is being pulled towards the winding wagon. This forward movement takes place automatically during the winding of the cable on the drum without it being necessary to raise the flanges out of the ground or to lower them again, and without

shape of the shares on the reversible plough, the depth of the furrow, the condition of the ground and the weather, and, not least, on the skill of manipulation. On an average, with a depth of furrow of from 15-35 cm. from 1·25 to 1·85 acres can be ploughed per hour, and the power necessary varies from 12 kw. hours per two thirds of an acre for surface ploughing in light soil, to 18 23 kw. hours for deep ploughing in heavy soil. It is not possible to give accurate costs of electric ploughing, as the working conditions vary so much and the power is also dependent on the working conditions, such as, for instance, whether

ploughing deep or surface, with or without sub-soil looseners, &c. The advantages of the single winder ploughing system are as follows:—

(1) The extremely simple use of the plough set by four men; (2) the great stability of the anchorage wagon; (3) the easy transportability of the separate parts of the plough set; (4) the great surface capacity with a minimum consumption of current; (5) the possibility of a change of speed during the working by means of carefully and conveniently arranged gear-changing apparatus.

Whether preference be given to this single winder or to the double winder ploughing system depends on the particular circumstances, and, consequently, can only be decided by considering the requirements of each particular case. For this reason it is usual to elicit from the farmer by means of an exhaustive questionnaire full details of the estate or farm, such as location, condition of soil (clay, sand, light or heavy, stony, roots, &c.), flat or hilly and, what grain or vegetables are most cultivated, frequency of ditches, maximum depth of ploughing required, and whether there are other implements to be moved at the same time.

It may be said that even if the single winder system were, on the basis of its lower cost of construction and the cheaper cable network required, to be chosen, the double winder system is preferable where the ground is so loose that the discs of the anchorage wagon cannot find sufficient hold, or where the ground, on the other hand, is so hard and firm that the discs cannot force their way into it. It is also to be preferred for other field work where the attached wire of the single winder system would be in the way, as would be the case, for instance, in potato-gathering machines, certain types of plough, &c.; or where, on large estates, importance is attached to obtaining particularly large outputs.

(c) The haulage cable used for both the double winder and single winder systems is of special steel wire (Tiegel steel wire patent) of high tensile strength. The ends of the cable to be attached to the farming implements are provided with fasteners constructed so as to prevent the fraying of the wire cable and to prevent its becoming entangled.

In the single winder ploughing system two guide rollers are provided on a bracket arm attached to one side of the ploughing implements, &c., to give support to the looped or non-working length of cable, and a special cable guiding carriage (Fig. 13) may, in addition, be supplied for supporting this cable in special cases.

The following particulars of pre-war costs of complete equipments—(a) on the single winder wagon system, (b) on the double winder wagon system—may be of interest.

(To be continued).

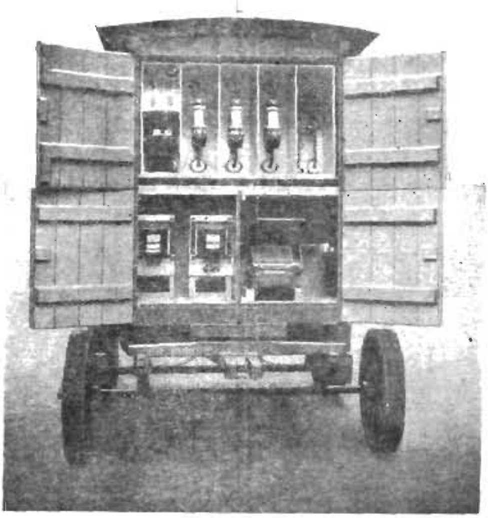

FIG. 3.—TRANSFORMER WAGON.
Low-tension Compartment Open, arranged for 1000 Volts and 380 Volt Low-tension Tappings.

DR. EDWARD ARDERN, F.I.C., formerly Chief Chemist, has been appointed Consulting Chemist to the Rivers Committee of the Manchester Corporation, and has joined Mr. S. E. Melling, F.I.C., Consulting Chemist to the Salford Corporation, Public Analyst for the County of Chester, &c., in practice as Analytical and Consulting Chemists, at The Cliff, Higher Broughton, Manchester.

## THE PART OF THE INDUSTRIAL CHEMIST TOWARD PRODUCING "HIGH COST OF LIVING."

By F. P. DUNNINGTON,
Professor of Applied Chemistry, University of Virginia

THE high and rising prices of our staple products and manufactures occasions much inquiry as to its limits and continuance. It may be that a view of one of the causes of this world-wide result will shed some light upon its nature, and afford valuable information as to its ultimate effects.

The economist advises us that the price of an article will increase with the demand for it, and will be diminished by an enlarged supply. In general, the prices of articles will present to us their relative values, but in the case of gold, which has long been our standard of value, its price is fixed by law at 20.67 dols. for one troy ounce. As to the demand, a small portion of the gold produced is used for jewellery and dentistry, but the remainder passes into circulation as coin, and the demand for this continues uniformly urgent.

Now let us consider the supply of gold. The method of mining gold, which is known as the cyanide process, was discovered in England about 1895. It is based upon the collection of finely-divided gold by a dilute water solution of sodium cyanide. By the use of this process large amounts of gold began then to be obtained from South Africa, soon reaching 100,000,000 dols. annually, which amount almost equalled that heretofore obtained from the whole world. Other countries also made use of this process, multiplying their output, and the United States has thus increased its annual production 150 per cent. The following approximations of the statistics available will more definitely express the facts:—

*Total Annual Production of Gold.*
(Figures in million dollars).

| Year. | In United States. | In world. |
|---|---|---|
| 1880 | 36 | 108 |
| 1885 | 32 | 106 |
| 1890 | 33 | 118 |
| 1895 | 46 | 200 |
| 1900 | 70 | 312 |
| 1905 | 88 | 380 |
| 1910 | 97 | 454 |
| 1911 | 97 | 461 |
| 1912 | 93 | 466 |
| 1913 | 89 | 456 |
| 1914 | 95 | 439 |
| 1915 | 101 | 470 |
| 1916 | 93 | 454 |
| 1917 | 84 | 424 |

From these figures we note the "outputs" for the years 1880 to 1890 were not far from constant; then began the rapid increase of gold mining; in five years, to an increase of 100 per cent, and in twenty years to 300 per cent. So that the world's annual output of gold has increased during twenty years to more than fourfold, and one cause, or surely the main cause, of this increase is the discovery of this cyanide process, a cause which must continue its effects, and therefore whatever the variations, we may look forward to no substantial decrease of this annual "output" in the future.

With this remarkable increase in the amount of gold very many other products have also been produced in larger amounts, possibly some 100 per cent, but certainly this increase in gold far surpasses the increase of any other products, and it must be inferred that gold has become therefore relatively of less value. But gold being our standard, if its value be lessened one-half, the prices of most materials must, by this fact, be doubled. In other words, there is but little commercial consumption of gold, most of the "output" is circulated as coin, and if this be multiplied proportionately more than are the staples of life, the coin must be (relatively) lessened in value, and the prices of all other commodities, &c., will be correspondingly increased. During the past twenty years many products have gradually risen in price, and since the war began the prices of many others have risen very rapidly. If we now review the prices of our staple products, all of which are still produced under usual conditions, we will note that the present average price of each of these is about double that prevailing from 1890 to 1900. Thus consider wheat, corn and hay, meat, milk and eggs, wood, oil and coal, cotton, wool and leather, iron, copper and tin, silver, zinc and lead, and articles manufactured from them.

(Tin is mined, smelted, and sold in Bauca and in Straits Settlements at (practically) same price in silver coin—the currency of that land—as during the past twenty years).

It is true that the peculiar and urgent demands of the war have raised the prices of some of these more than 100 per cent, yet we may well expect when the war is over that prices must in the main settle to a level which will for each be about double what it was in 1895. The supply of our standard, gold, will surely continue without diminution, and eventually the price of all other commodities, properties, and services must correspondingly increase before any settled adjustment can be experienced.

However we may be inclined to resist, it seems but logical to promptly accept the results which arise from these present and abiding facts. There is much room to question what raising of prices should be designated as "profiteering" and what is but the natural change toward a settled adjustment of values, so long as gold still stands apart from all else as the one standard.—*Manufacturers Record, Baltimore*, October 17, 1918.

## A COMPARISON OF DOLOMITES.

By ALBERT ROTHROCK and J. B. SHUMAKER.

WE were fortunate in being able to secure a number of specimens of dolomite from different countries through the courtesy of R. M. Wilke, of Palo Alto, California. Our purpose in studying these rocks from different places was to determine how widely the so-called dolomites vary from the typical mineral or rock. The typical dolomite, $CaCO_3,MgCO_3$, 54·35 per cent $CaCO_3$ and 45·65 per cent $MgCO_3$, possibly never occurs in nature; but one or the other, or both, of the constituents are replaced by various other substances.

1. Dolomite from Ossining, New York. A white crystalline variety, quite compact, as the specific gravity is 2·93. The silica content is rather high.

| | Per cent. |
|---|---|
| $SiO_2$ | 10·61 |
| $Fe_2O_3$ | 0·20 |
| $Al_2O_3$ | trace |
| $CaCO_3$ | 51·97 |
| $MgCO_3$ | 37·40 |
| | 100·18 |

2. A specimen from Cumberland, England. A dark grey massive dolomite with a specific gravity of 2·88. The iron content is notably high with a small quantity of silica.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·56 |
| $Fe_2O_3$ | 16·05 |
| $Al_2O_3$ | 0·87 |
| $CaCO_3$ | 57·59 |
| $MgCO_3$ | 24·98 |
| | 100·05 |

3. Specimen from Cerro Gordo, Ingo County, California. It is a light coloured massive variety, with n

apparent crystalline structure. This is more a limestone than a dolomite on account of the small magnesian content. The specific gravity is 2·57.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·06 |
| $Fe_2O_3$ | 0·09 |
| $CaCO_3$ | 87·88 |
| $MgCO_3$ | 11·85 |
| | 99·88 |

4. Specimen from Frankenstein, Germany. A massive grey compact and hard variety, breaking with a concboidal fracture. The structure is apparently not granular nor crystalline. In composition it departs quite widely from a true dolomite, approaching magnesite in the large magnesian content. The specific gravity is 2·9.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·13 |
| $Fe_2O_3$ | 3·71 |
| $Al_2O_3$ | 0·73 |
| $CaCO_3$ | 27·04 |
| $MgCO_3$ | 67·91 |
| | 99·52 |

5. Specimen from near Keeler, California. It is white, very hard, compact, crystalline, resembling marble. It has such a small magnesian content that it cannot be considered a dolomite. The specific gravity is 2·7.

| | Per cent. |
|---|---|
| $SiO_2$ | 32·57 |
| $Fe_2O_3$ | 0·06 |
| $CaCO_3$ | 66·08 |
| $MgCO_3$ | 1·15 |
| | 99·86 |

6. A specimen from Binnenthal, Switzerland. It is greyish white in colour, containing transparent crystals of varying size, and resembles marble. It crumbles easily and has an appearance somewhat resembling loaf-sugar. In composition it may be considered a dolomite, with a large silica content. Its specific gravity is 2·85.

| | Per cent. |
|---|---|
| $SiO_2$ | 10·84 |
| $Fe_2O_3$ | 0·48 |
| $CaCO_3$ | 49·00 |
| $MgCO_3$ | 40·23 |
| | 100·55 |

7. A specimen from Gerolstein, Germany. A hard compact massive variety, with a specific gravity of 2·82. It approximates very closely a typical dolomite in composition, and is similar to the dolomites of north-eastern Iowa.

| | Per cent. |
|---|---|
| $SiO_2$ | 1·23 |
| $Fe_2O_3$ | 0·80 |
| $Al_2O_3$ | 0·22 |
| $CaCO_3$ | 52·93 |
| $MgCO_3$ | 44·33 |
| | 99·51 |

8. A ferriferous specimen from Costa da Val, Tyrol. This has a pearly lustre, and is composed of coarse particles, light in colour, permeated with yellow streaks. The specific gravity is 3·01

| | Per cent. |
|---|---|
| $SiO_2$ | 0·12 |
| $Fe_2O_3$ | 2·36 |
| $FeCO_3$ | 23·44 |
| $CaCO_3$ | 49·59 |
| $MgCO_3$ | 24·50 |
| | 100·01 |

It quite closely approximates the formula—

$$2CaCO_3,MgCO_3,FeCO_3.$$

9. A specimen from New Almadin, California. It is a hard greyish white variety, very compact, composed of long coarse crystals, one surface coated with a brown deposit. The specific gravity is 2·8

| | Per cent. |
|---|---|
| $SiO_2$ | 0·4 |
| $Fe_2O_3$ | 8·57 |
| $CaCO_3$ | 53·28 |
| $MgCO_3$ | 45·18 |
| | 100·11 (?) |

10. A specimen from Raible, Carintbia. This is a light-grey variety, composed of fine granular crystals of varying shades, and is somewhat porous. The specimen is unusually pure, and is almost a perfectly typical dolomite. The specific gravity is 2·7.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·23 |
| $Fe_2O_3$ | trace |
| $Al_2O_3$ | 0·28 |
| $CaCO_3$ | 54·64 |
| $MgCO_3$ | 45·18 |
| | 100·33 |

11. Dolomite from Brewster's, New York. The specimen consists of large rhombic crystals of a grey colous. The specific gravity is 2·9.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·33 |
| $Fe_2O_3$ | 2·44 |
| $CaCO_3$ | 59·98 |
| $MgCO_3$ | 36·83 |
| | 99·58 |

12. A specimen from Missouri. Two distinct portions are apparent. The outer layer is composed of light pink crystals, with a small amount of silica in their composition. The inner portion is made up of dark grey crystals containing a larger amount of silica.

(a) *Outer Portion.*

| | Per cent. |
|---|---|
| $SiO_2$ | 0·23 |
| $Fe_2O_3$ | 1·18 |
| $Al_2O_3$ | 0·63 |
| $CaCO_3$ | 56·63 |
| $MgCO_3$ | 41·37 |
| | 100·04 |

(b) *The Interior Portion.*

| | Per cent. |
|---|---|
| $SiO_2$ | 3·96 |
| $Fe_2O_3$ | 0·89 |
| $Al_2O_3$ | 1·16 |
| $CaCO_3$ | 57·18 |
| $MgCO_3$ | 36·83 |
| | 100·02 |

13. Specimen from "The Dolomites," in the Austrian Tyrol, obtained by Mr. R. M. Wilke in person. A grey variety having a specific gravity of 2·73. This particular specimen had a beautiful carnallite embedded in its surface.

| | Per cent. |
|---|---|
| $SiO_2$ | 0·48 |
| $Fe_2O_3$ | 0·56 |
| $Al_2O_3$ | 0·57 |
| $CaCO_3$ | 94·21 |
| $MgCO_3$ | 4·15 |
| | 99·97 |

The rock was somewhat disappointing, coming from the locality that gave the name to this class of minerals and rocks. It is not a dolomite, but a specimen of quite ordinary limestone.

It would seem that all the supposed dolomite in that famous region comes short of expectations. A specimen obtained from Brenner in the Brenner Pass between Austria and Italy gave the following results on analysis:—

| | Per cent. |
|---|---|
| $SO_2$ .. .. .. .. .. .. | 0·35 |
| $Fe_2O_2$ and $Al_2O_3$ .. .. | 0·50 |
| $CaCO_3$ .. .. .. .. .. | 96·25 |
| $MgCO_3$ .. .. .. .. .. | 2·98 |
| | 100·08 |

The specimen is such a pure variety of limestone that it could be used in the manufacture of calcium carbide, on account of the small magnesia content.

Minerals and rocks that may fairly be classed as dolomites vary in quite wide limits, while many so-called dolomites, on account of their small magnesian contents, are ordinary limestone.

Cornell College, Mount Vernon, Iowa,
*December 20, 1919.*

## BRITISH INDUSTRIES FAIR.

THE British Industries Fair of 1920, released from the restrictions imposed by the war, is on a scale worthy of our Imperial world trade. Although the Board of Trade succeeded in securing the Crystal Palace, the largest exhibition building in the world, for the London Fair, so great has been the demand for space by British manufacturers that it has been necessary to reduce the allotments by no less than 20 per cent. Even so, there is a waiting list for possible vacancies in each section of the Fair.

The three Fairs, though held in different cities (London, Birmingham, and Glasgow) are in reality one Fair, each city's exhibition being devoted to special branches of industry. All three are concurrent from February 23 to March 5. The London Fair is directly organised by the Department of Overseas Trades (Foreign Office and Board of Trade), while the Fairs at Birmingham and Glasgow are organised by the municipalities under the auspices of the Board. An important point in this system is that no one industry may exhibit at two Fairs.

All three are Trade Fairs, as distinct from exhibitions, admittance being limited to bona-fide buyers by invitation only. Participation in the Fairs is confined to genuinely British manufacturing firms. Only goods suitable for inclusion in trade fairs are allowed. Buyers do not, for instance, have to waste their time passing exhibits of locomotives and heavy guns such as are sometimes shown in Continental fairs.

### *Prospects and Results.*

Judging from the results of the past five years the prospects of the British Industries Fair are of the brightest. Year by year the number of exhibitors, even under war conditions, has increased steadily. The flow of visiting buyers has kept pace with the advance in exhibits; at the last Fair, for instance, the number of buyers passing the turnstiles each day was roughly a thousand more than in 1918. Obviously this has resulted in a growing volume of actual business transactions. If proof be needed, it should be sufficient to quote a case reported to the Department by an exhibiting firm, who opened no fewer than 500 new accounts, 200 of which were with Overseas buyers, during the ten days of the last Fair. Only years of steady work and expensive advertising could have given such a result had not the British Industries Fair brought together the men who wished to buy and the firm with goods worth buying.

To the buyer also the Fair has proved its value owing to the careful classification of the exhibiting trades and their collection under one roof. Too often on the Continent exhibits are scattered far and wide through a town, involving endless hunting for sections and much loss of the time which is money. When the buyer has inspected the stands in any particular section of the British Industries Fair he has seen practically the whole range of national production in that trade. To make such an inspection except at the Fair would be a labour of months.

### *Helping the Buyer.*

The services rendered to the invited buyer do not, however, end with the mere bringing together under one roof of the chief British manufacturers. The resources of the home Government are at his call. In the Fair building itself the Department of Overseas Trade opens a fully staffed office in order that both buyers and exhibitors may obtain authentic information on all points of importance, such as tariffs, shipping, transport, and the status of firms.

Nor does the Department's help stop with advice and information. Material arrangements are made for the buyer's assistance at the Fair. Interpreters are provided for his use, free of charge. Writing rooms are set apart for his convenience, where he can carry on his correspondence, which is dealt with by a special Post Office in the Fair building. The provision of restaurants and tea-rooms makes it unnecessary for him to leave the Fair building to get his meals.

### *Catalogue.*

The headings in the catalogue of the Fair are not in English only. Instead of being a mere list of the names of the exhibitors it is a book of reference in which the buyer finds in his own language an index of every article exhibited. In fact, all that foresight and experience can do to make the British Industries Fair, 1920, a business-like centre for business is done.

## THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ.

(Continued from p. 17).

II. *The Electrolysis of Uranyl Sulphate Solution.*

BUNSEN (*Pogg. Ann.*, xci., 619; *Journ. Prakt. Chem.*, lxii., 178) and also Carveth and Mott (*Journ. Phys. Chem.*, 1905, ix., 231) were able to obtain metallic chromium by electrolysing a chromous chloride or chromous sulphate solution with high current density. They used an unglazed porous cup as a diaphragm. Because of the strong analogy between chromium and uranium, their method of procedure was tried.

Experiments were carried out in various ways. Different current densities were used in different temperatures, varying from 0° to boiling. Strong acid solutions, weak acid solutions, neutral solutions, and solutions made alkaline with ammonia after adding hydroxylamine to hold the uranium in solution were tried. Many of the deposits obtained had a metallic appearance, but they were always contaminated with the black oxide or with a sulphote. The electrodes were also varied. The material tried as electrodes were platinum smooth and roughened, copper, carbon, graphite, and nickel. The deposits formed with the different electrodes were always the same in general properties varying with the kind of solution used, the current density, temperature, and length of run. In

* From the *Journal of Physical Chemistry*, xxxiii., No. 8.

TABLE V.—*Summarised Data of the Electrolytic Experiments.*

| Experiment. | Cathode. | Character of electrolyte. | Volts. | N.D.100 in ampères. | Character of deposit. | Time of run. | Weight of deposit. Grm. | Uranium content. Per cent. | Potential. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Platinum | Acid $H_2SO_3$. | 7 | 14·55 | No deposit. | 2 hours. | — | — | — | — |
| 2. | Platinum. | Slightly acid $H_2SO_4$. | 7 | 10·00 | Metallic, mixed with black oxide. | 1 hour. | Too small to weigh. | — | — | A green hydroxide precipitated. |
| 3. | Platinum. | Slightly acid $H_2SO_4$. | 7 | 17·5 | Metallic, mixed with oxide. | 1 hour. | 0·0195 | — | — | Diaphragm used, anolyte 1·12 sp. gr. $H_2SO_4$. |
| 4. | Platinum. | Slightly acid $H_2SO_4$. | 4 | 2·58 | Black oxide with green tinge. | 3 hours. | 0·1098 | 62·25 | — | Greenish yellow precipitate in cathode compartment. |
| 5. | Platinum. | Strongly acid $H_2SO_4$. | 3·5 | 3·50 | No deposit. | 2 hours. | — | — | — | — |
| 5. | Platinum. | Reduced acidity with $Na_2CO_3$. | 3·5 | 2·50 | Greenish white, with black oxide. | 2 hours. | 0·0356 | — | — | Yellow oxide precipitated in cathode compartment. |
| 6. | Platinum. | 10 per cent solution $UO_2SO_4$ in water neutral or slightly acid by hydrolysis. | 5 | 2·15 | Brownish, tinged with green, poorly adherent. | 3 hours. | 0·1569 | 68·20 | — | Reddish brown precipitate in cathode compartment. |
| 7. | Platinum. | 10 per cent solution $UO_2SO_4$, neutral. | 8·75 | 3·88 | Dense black coat covered with yellow oxide. | 1 hour. | Small. | — | — | Cathode compartment contained a precipitate of yellow oxide. |
| 8. | Platinum. | 10 per cent solution $UO_2SO_4$, strongly acid. | 3 | 11·6 | No deposit. | 2 hours. | — | — | — | Solution in cathode compartment reduced. |
| 9. | Platinum. | 10 per cent solution, slightly acid $H_2SO_4$. | 8·5 | 2·2 | Brown-black deposit, with tinge of green. | 20 mins. | 0·1854 | 60·50 | — | Solution in cathode compartment completely reduced and dissolved. |
| 10. | Platinum. | 10 per cent solution, slightly acid $H_2SO_4$. | 11 | :2 | Brown-black, with yellow adhering. | 20 mins. | — | — | −0·6295 | Cathode compartment filled with yellow precipitate. |
| 11. | Platinum. | 10 per cent solution $UO_2SO_4$, acid and treated with formaldehyde. | 5·5 | 2·48 | Greenish crystals, with dark metallic deposit beneath. | 1 hour. | 0·0940 | 64·60 | — | Green crystals, when dried were grey-yellow mixed with black beneath; diaphragm used. |
| 12. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, acid and treated with formaldehyde. | 11 | 10·82 | Black, with green crystals stuck to electrode. | 20 mins. | 0·0200 | — | — | Solution boiled; deposit poorly adherent; diaphragm used. |
| 13. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 7 | 15·28 | Metallic beneath crystals which washed off. | 25 mins. | 0·026 | — | — | Deposit very hard to remove $HNO_3$. |
| 14. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 10 | 12·50 | Metallic beneath green powder that washed off. | 25 mins. | 0·0120 | — | — | Solution kept cool by ice-water bath. |
| 15. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 10 | 13·00 | Bronze beneath solution. Crystals near surface that broke off. | 1 hour. | 0·0620 | — | −0·3259 | Brown precipitate in bottom of cathode compartment. |
| 16. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 20 | 27·8 | Deposit brown, changed to yellow on standing. | 20 mins. | 0·050 | — | — | Solution boiled. |
| 17. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 18 | 5·00 | Small amount of white slimy material that washed off. | 1 hour. | — | — | — | Cathode compartment full of black precipitate. |
| 18. | Platinum, rotating. | 10 per cent solution $UO_2SO_4$, 1 cc. concentrated $H_2SO_4$. | 18·5 | 10·6 | Yellowish in spots, *slightly green in others.* Probably adherent. | 1 hour. | 0·1487 | 42·00 | — | Deposit also had sulphate present. Temperature of bath 40°. |

strongly acid solutions the amount of deposit obtained was always small. The solutions showed by their colour a reduction to uranous sulphate and all the solutions remained clear. The solution,s neutral at the beginning, soon precipitated a voluminous yellow deposit that settled to the bottom of the container, thus depleting the solution of the electrolyte. When this occurred the solution showed an acid reaction, but the acid content was not sufficient to hold the deposit in solution while the current was running. When a porous cup was used as a diaphragm the cathode compartment contained reduced uranium sulphate and the solution in the anode compartment remained that of the uranyl salt.

Table V. contains the summarised data of the electolytic experiments.

As shown in the table the electrolysis of a sulphate solution of uranium has been tried under varying conditions. Wherever sufficient deposit has been obtained for analysis, the analysis has been made. Potential readings could not be obtained on all, because when dried the platinum was exposed. Some of the deposits had a decidedly metallic appearance, were difficultly soluble in nitric acid, and in many respects resembled metallic uranium, but the product was so contaminated with oxide and sulphate that no analysis of the metallic looking portion could be obtained. It is impossible to get a deposit of pure metallic uranium under any of the conditions tried, though some metal seems to be deposited at higher current densities. This, however, is always contaminated with the oxide.

(To be continued).

## BRITISH CHINA TRADE BUREAU.

The British China Trade Bureau (Publicity Bureau for South China) has been transferred to the Federation of British Industries.

The transference of the London organisation of the British China Trade Bureau from its offices in Regent House, Regent Street, to the headquarters of the Federation of British Industries is a step in the direction of practical co-operation between manufacturers and merchants.

Mr. C. Montague Ede, the well-known General Manager of the Union Insurance Society of Canton, Ltd., is responsible for having induced the Federation to assume the direction of the British China Trade Bureau in this country. This Bureau was an organisation set on foot to provide an essential link between the home manufacturer and the distributing merchant in China on the one hand, and a consuming population of fifty millions of people on the other.

It was realised that if British enterprise was to make headway against the powerful trade propaganda of the Japanese in this market, some form of counteracting activity had become necessary for British trade. The Bureau established its own organisation throughout the four provinces of Kwangtung, Kwangsi, Yunnan, and Kaeichow, with the result that to-day it exercises a controlling influence over nearly 100 newspapers published in the vernacular. Amongst its other activities it is prepared, free of charge or commission, to introduce British manufacturers at home to British merchants in China, or *vice versa*.

The Bureau has in its possession a mass of valuable information relating to market conditions throughout the regions in which it operates. The importance of the Federation of British Industries taking over the direction of the Bureau in London cannot be too highly estimated.

The new direction of the Bureau's activities in London will be placed under the superintendence of Mr. Henry Hobden, who is now in charge of the China Section of the Overseas Trade Organisation of the Federation. Mr. Hobden is well known as an authority on trade conditions in China, and during the latter period of the war was one of Sir Arthur Steel-Maitland's most able lieutenants in the Department of Overseas Trade, where he had charge of the Far Eastern Section.

Mr. Montague Ede has been the leading spirit in the little band of patriotic and public spirited gentlemen engaged in various forms of commercial enterprise in Hong Kong, whose efforts resulted in bringing the British China Trade Bureau into existence during the period of the war, and it is especially due to his efforts that the Federation has taken over the London organisation of this body.

## TRINIDAD LAKE ASPHALT.

The famous asphalt lake in Trinidad has always presented great difficulties in efforts to ascertain its depth through boring operations, as the constant movement of the asphalt tends to break, or render crooked, pipes or boring appliances driven into the lake at any considerable depth. Some borings, however, recently made under the direction of the chief geologist of the New Trinidad Lake Asphalt Co., which has the concession from the Trinidad Government for mining asphalt from the lake, have reached a depth of 150 ft., the lowest depth yet obtained. The previous record was 135 ft., reached in 1893. On both occasions the asphalt was found to have the same uniform character as in borings higher up and in other parts of the lake.

The record borings made in 1893 were accomplished by driving down a 2-inch pipe and washing the material out of the pipe by means of a jet with a steel bit on the bottom of it. At the depth of 135 ft. the pipe became so crooked, owing to the movement of the asphalt, that further progress was impossible.

In the borings which have recently been made, writes the United States Consul in Trinidad, a core of asphalt was taken by driving a small pipe into the pitch and then withdrawing it with its contained core of pitch. Following this, a pipe of 2-in. diameter was driven to the lowest depth to which the core was taken, and the material, forced into it by driving, was removed by means of a water jet and bit. Another core was taken below the 2-in. pipe in the untouched pipe. The deepest of these borings was taken at the centre of the pitch lake, and the asphalt was found to be of uniform character throughout. After completion this hole was observed to have shifted at the surface 25 ft. in six weeks; a survey showed the movement to exist as deep as 100 ft., and there was a suggestion that the direction was reversed at a depth of between 25 ft. and 50 ft. The other borings, not at the centre of the lake, shifted to a lesser extent. The movement of the asphalt seems to be similar in many respects to the ascending and descending currents in a kettle of boiling water.

The asphalt lake of Trinidad is situated at Brighton, 12 miles west of San Fernando, 27 miles south of Port-of-Spain, and about half a mile from the Gulf of Paria. The lake itself is a flat area of approximately 120 acres, forming a basin surrounded by a low hill.

The original elevation of the lake surface was 137½ ft. above sea-level, but mining operations had lowered this elevation to about 130 ft. in 1918. The asphalt is dug by hand by labourers using a mattock, which, at each stroke, lifts the asphalt out in single chunks weighing usually 60 lb. The labourers carry these large blocks upon their heads to the cars in which they are hauled away.

Crude asphalt as it occurs in the lake is of a very uniform composition, as has been determined by a large number of analyses. The composition is approximately 30 per cent moisture, 60 per cent asphalt in a very intimate uniform emulsion, in which a large portion of the material is in a colloidal condition, and a small amount of mineral matter. During the process of heating or

drying the moisture is removed by evaporation, but the mineral matter and asphalt remain in their same uniform proportions, which is one of the important properties peculiar to the Trinidad Lake asphalt, and not common to other mechanical mixtures of asphalt and mineral matter. In appearance asphalt, when dried, changes from a dull black spongy substance to a hard brittle jet-black shiny product. Animals or wagons could pass across the lake if they would continue moving, but any weight allowed to remain quiet upon the surface will sink.

From the lake there are two systems of tramway. One is operated by an endless cable, which takes the cars to a terminal station, where the buckets of asphalt are transferred to an overhead cable tramway, conveyed to the loading jetty, a distance of nearly a mile, there dumped into the holds of steamers, and shipped to foreign markets as crude Trinidad Lake asphalt. The second system carries the asphalt in cars of approximately one ton capacity up an incline to the drying plant, where they dump direct into drying stills. In these the moisture is driven off by means of steam coils, and after two days' heating the asphalt is drawn off in a molten condition from the bottom of the drying stills, poured into barrels, and placed in the storage shed until ready for shipment. Then the barrels are rolled from the shed to carriers on the overhead tramway, conveyed to the loading jetty, and lowered into the hold of the steamer.

The holes dug in mining the asphalt soon fill to the same level as the rest of the lake, thus enabling digging to be repeatedly done in the same places. The lake is in constant but slow and powerful movement, and material left upon the surface frequently shifts its position and finally subsides. Over the surface of the lake there are a number of peculiar V-shaped crevices, very sharp at the bottom, with convex side slopes, apparently places where the asphalt descends from either side. To balance this descending movement there are small raised places from 1 in. to 4 in. higher than the average flat surface, at which the ascending movement probably occurs.

In many parts of the lake, particularly near the centre, a gas containing hydrogen sulphide is given off in noticeable quantities, and any brass material left near the centre of the lake is tarnished in less than a day. The gas is similar to that obtained in the oil wells within sight of the lake. During the dry season the water, which is in the pools near the centre of the lake, and which has not been diluted by rain, is slightly mineralised, indicating a possible origin below the surface. The quantity is small, and during the dry season becomes practically negligible. During the rainy season a great deal of water flows into the basin of the pitch lake, and after a succession of hard rains it is completely covered with water, which is pumped off, however, by means of electric centrifugal pumps.

At the centre of the pitch lake there is an area of soft black sticky viscous asphalt, approximately 50 ft. wide.

In various portions, scattered about the surface of the lakes, are "islands" often 300 ft. long, on which trees are growing. When removed to facilitate mining operations these "islands" appear to consist principally of a thin layer of decayed vegetation and soil, the bottom of the layer being of various depths, very much creased, and seldom extending deeper than 3 ft.

Throughout the area east, north, and west of the pitch lake, and extending to the sea, which is less than a mile distant, are many small areas or patches of asphalt of variable composition, constancy, and appearance; these are the source of what is called "Trinidad Lake asphalt." Shipments of this substance have been made at various times, but the quantity shipped is very small, and it has been almost nothing since 1910.

At Guanoco, State of Socre, Venezuela, there is another asphalt lake known as the Bermudez Lake, from which large shipments have been made, almost entirely to the United States This lake is of a different character, and the asphalt is quite unlike that from the Trinidad Lake.—*Journal of the Royal Society of Arts*, xlviii., No. 3502.

## PURCHASE OF LIME ON FARMS.

RECENT quotations for different kinds of lime are as follows:—

| | Price per ton. |
|---|---|
| Ordinary lime.. .. .. .. .. .. | 28s. |
| Ground lime .. .. .. .. .. .. | 42s. |
| „ limestone .. .. .. .. .. | 34s. |

and the question arises, which of these is the best value?

Lime is usually about 90 per cent pure; limestone also is equally pure, but it contains carbonic acid (which is of no value to the farmer) in addition to lime, so that its content of the valuable lime on the 90 per cent basis of purity is reduced to 51 per cent. The relative cost per ton of lime therefore works out as follows:—

| | Price per ton. |
|---|---|
| Ordinary lime.. .. .. .. .. .. | 28s. |
| Ground lime .. .. .. .. .. .. | 42s. |
| „ limestone .. .. .. .. .. | 60·5s. |

The difference in value between ordinary lime and ground lime lies in the fineness of division. The ground lime, being in fine powder, can be well distributed in the soil, and, therefore, need not be used in as large dressings as the ordinary lime. Whether there is as much difference as is shown in these quotations depends on the actual samples. Limestone has one advantage over ground lime; it can be kept more easily in the bag, as it does not swell and become hot on wetting in the way lime does. In many places, however, lime is available at a cheaper rate than any of the above. Prof. Gilchrist reports an instance in which waste lime is being offered at 8s. per ton (on rail), which, assuming only 36 per cent of lime, is equivalent to a cost of 20s. for lime on the 90 per cent basis. It is, however, variable in composition, and contains from 60 to 70 per cent carbonate of lime, which is equivalent to 34 to 39 per cent of lime. The carbonate of lime is in a finely precipitated powder. At Cockle Park, 4 tons per acre of this has effectively checked finger-and-toe disease in turnips, and in other ways has given valuable results. It is carefully spread direct from the carts on to the soil, before ploughing the ley for oats, at the rate of 4 tons per acre, and this application once in a rotation of four or six years has been as effective as any form of lime used.

Mr. Scott-Robertson reports two waste limes from Essex; the figures of analysis are as follows:—

| | Sample 1. Per cent. | Sample 2. Per cent. |
|---|---|---|
| Moisture .. .. .. .. | 37·92 | — |
| Calcium oxide (lime) .. | 31·13 | 40·53 |
| Sand, &c... .. .. .. .. | — | 4·70 |

Sample 2 comes from a soap works in Essex, and costs 1s. 6d. per ton free on rail. Sample 1, which was very wet and pasty, is derived from a factory in the London area, and costs at the time of writing 6s. 6d. per ton free on rail at the works.—*Journal of the Board of Agriculture*, xxvi., No. 9.

OPENING FOR DYESTUFFS AND COLOURS IN INDIA.—There is a big field for dyestuffs in India. In pre-war days all or most of the dyes were imported from Germany, but since the beginning of the war India has been dependent upon the United Kingdom, which has been unable to supply some colours, while in the case of those which are being imported the supply is inadequate to the demand. The United Kingdom has been unable to manufacture or supply several of what are known as the basic colours with the result that the Government of India has decided to issue licences to those who want dyes to secure them where they can. On the other hand, some of the dyes manufactured in the United Kingdom, such as sulphur black and red, compete favourably with and even excel the German productions. So far as prices are concerned the United Kingdom compares favourably with any other country.—*Reuter's Trade Service.*

## NOTICES OF BOOKS.

*The Nature of Enzyme Action.* By W. M. BAYLISS, M.A., D.Sc., F.R.S. Fourth Edition. Pp. viii+190 (Monographs on Biochemistry). Longmans, Green, and Co., 39, Paternoster Row, London. 1919. Price 7s. 6d. net.

THIS monograph is based upon lectures delivered by the author at University College, and indicates very clearly the present state of our knowledge of this subject.

Detailed descriptions of a large number of specific enzymes are avoided, and the book deals only with the general, physical, and chemical properties of these bodies and the laws govering their action.

The commencement of the book shows the similarity between enzyme and catalytic action, and indicates the colloidal nature of enzymes.

This is followed by chapters on general methods of preparation and investigation, the mode of action of enzymes, co-enzymes and anti-enzymes, zymogens, &c.

There is a short statement of general conclusions, and the book is completed by a very full bibliography and index.

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*The Preparation of Organic Compounds.* Second Edition. By E. DE BARRY BARNETT, B.Sc. (Lond.), A.I.C. Pp. xv+273. London: J. and A. Churchill, 7, Great Marlborough Street. Price 10s. 6d. 1920.

WHEN a book is published in a second edition it is usually the criterion of its acceptance by those for whom it is intended. This book is no exception to that rule. It is written primarily for students as a laboratory manual and covers a large area in organic chemistry.

The first chapter is devoted to short descriptions of the apparatus used both in the laboratory and in the works. The author points out that saucepans, jam-pots, &c., are equally as efficient for the carrying out of most organic reactions as glassware.

Chapter II. commences the organic preparations and continues through ten chapters. Each chapter deals with the preparation of a certain type of compound; for example, Chapter II. deals with hydrocarbons, while Chapter III. deals with halogen compounds, and Chapter IV. with the preparation of alcohols, and so on. Chapter XIII., the last chapter, is headed "Miscellaneous Types," and the modes of preparation of dyes and other compounds not possible for correlation into groups are discussed herein.

When possible an alternative method is given for the preparation of a compound.

The author, besides giving the method of preparation, endeavoors to outline the usefulness of the reaction taking place, by means of a theoretical explanation and also by means of formulæ and equations which are of great value.

Other points worth mentioning are the footnotes and index. The footnotes refer to where one can find a fuller description of the article under consideration. With reference to the index, when the method of preparation for a compound is given its page can be found in heavy type in the index.

The book is well written and can be recommended.

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*The Condensed Chemical Dictionary.* Compiled and Edited by the Editorial Staff of the Chemical Engineering Catalog, F. M. THONER, jun., D. D. BEROLZHEIMER, W. P. CUTTER, JOHN HELFRICH. First Edition. Pp. 525. The Chemical Catalog Company, Inc., 1, Madison Avenue, New York. Price 5.00 dols.

THIS will be found a most useful volume both to chemists and to the large body of non-technical people, including exporters and importers, brokers, purchasing agents, lawyers, insurance companies, &c., to whom such information as is given is often very useful, but who have not immediate access to large technical books.

The information given is brief but to the point, and includes such items as the colour, properties, uses, and physical constants of the substance, derivation, under which is given as short an outline as possible of the method of production. The grades in which the substance is met with in commerce and the containers generally used for transporting it are also given.

The Fire Hazard and Railroad Shipping Regulations are those existing in the United States, but they form a good guide for other countries.

At the end of the book are useful temperature conversion tables, metric equivalents, atomic weights, &c., together with explanations of some of the terms used in the book.

We are of opinion that this dictionary will in many cases prove to be an excellent time-saver, and the authors are to be congratulated upon getting such a mass of varied information into a single volume.

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*Official Directory of the British Chemical Manufacturers,* 1919. Pp. 344. Secretary, Captain G. Mount, D.S.O., 166, Piccadilly, W. 1.

THE "Official Directory of the Association of British Chemical Manufacturers" has just been received. It contains a list of the members of the Association with a classified list of their products and manufactures, which, besides being written in English, is written in six foreign languages, namely, French, Spanish, Italian, Portugeuse, Russian, and Japanese. A list of proprietary and trade names together with their chemical names is also inserted. The last hundred pages of the book is made up with announcements of the products manufactured by members of the Association.

### BOOKS RECEIVED.

"Industrial Gases." By H. C. GREENWOOD, O.B.E., D.Sc. (Manchester), F.I.C. Pp. xvii+371. London: Ballière, Tindall, and Cox, 8, Henrietta Street, W.C. 1920. 12s. 6d. net.

"Popular Chemical Dictionary." By C. T. KINGZETT, F.I.C., F.C.S. Pp. vi+368. London: Ballière, Tindall, and Cox, 8, Henrietta Street, W.C. 1920.

## NOTES.

NEW DYE PRODUCED IN UNITED STATES.—The National Aniline and Chemical Co., Inc., announces the production of a new dye, known as alizarol grey DG. This is a shade of pearl grey, and is similar to alizarol black 3 G, except that the shade is somewhat redder and duller. The *Philadelphia Public Ledger* states that the new dye possesses good fastness to light, water, and acids.—*Reuter's Trade Service.*

THE arrangements for the British Industries Fair (Birmingham), to be held at Castle Bromwich Aerodrome from February 23 to March 5, are rapidly approaching completion. The exhibitors number 650, and 100,000 square feet of space has been taken. The Chamber of Commerce is providing hospitality and social amenities to overseas buyers. The Fair is under the joint organisation of the Chamber and the Birmingham Municipality and under the auspices of the Board of Trade. The chief features will be general hardware and engineering, the latter group being represented by 200 firms. In the display of engines, in operation, a great advance will be noted in the production of all classes of oil engines, particularly those in demand in India and the Near East. The Fair will strongly appeal to the metallurgist and chemical engineer. The advances made in industrial chemical research is particularly noticeable in the display of glass for electrical and other purposes. The section devoted to paints, colours, and varnishes (the last named is strongly represented) is well filled.

Great interest is being aroused with regard to the Glasgow British Industries Fair which opens in the Kelvin Hall of Industries, Kelvingrove, on February 23. It will remain open for a fortnight. The Corporation of Glasgow, in conjunction with the Board of Trade, have made elaborate arrangements to make the Exhibition a success. The show will be run concurrently with one in London and Birmingham, different classes of exhibits being arranged for each exhibition. At Glasgow, for instance, the classification of trades are as follows:—Textiles; chemicals, light and heavy; dyes; foodstuffs, prepared and preserved; boots, shoes, slippers, and leggings; and cardboard boxes. The chemical and dyes section will form an important one, a large number of outstanding firms having booked stands. These include the British Dye Stuffs Corporation; Scottish Dyes, Ltd.; Brotherton and Co., Ltd.; Poynter, Son, and Macdonald,; Perry and Hope; Brunner, Mond, and Co., Liverpool; Borax Company; Bryant and May; Centrale Chemical Company; J. C. Barr, Ltd.; and Thomas Henderson, Ltd. The Board of Trade have now issued invitations to foreign and Colonial buyers to visit the show.

At the Sign of the Tin Hat.—Among the many after-the-war problems that are being pressed for solution, there is danger of one of the most self-sacrificing sections of ex-Service men being overlooked. It is, of course, right that suitable positions should be found for the demobilised, but what of those men and women who abandoned their business or profession to answer their Country's call. Of all the people who have suffered financially through the War none has been hit so hard as the tradesman or professional man, who had to give up his business, or practice, or in some cases leave it in the hands of incapable understudies, while he went to serve. In many cases they were men who, after years of training, were just launching out into small endeavours of their own—businesses, in most cases dependent on personal skill or effort, or goodwill. The Ex-Service Professional and Commercial Association, which has just been formed, is attempting to solve this problem. It is felt that if the general public but knew the difficulties being faced by many of these men now returning to civilian life they would rally round them and assist by their patronage and help. The Association is to be composed of ex-service tradesmen and professional men, and will provide the means of distinguishing the fact that they served by issuing an authorised sign, to be known as "The Sign of the Tin Hat." This sign will be affixed by members to their shop windows or brass plates, and be printed on their note-paper, and wherever this badge is seen it will be known that the proprietor of the business is an ex-service man or women, and is, therefore, entitled to the primary consideration of your custom. As the prospectus says, if the Association can do no more than induce the 5,000,000 ex-Service men and women to trade, as far as possible, with each other, it will have accomplished a great thing, and those of the public who have not forgotten the services rendered by the men who gave up everything for their country, will surely give preference to an ex-service trader, providing equal value for money can be obtained. The Head Offices of the Association are at 38-39, Piccadilly, London, W.

Development of British Guiana.—British Guiana has never been in the limelight as it is at the present time, thanks to the advertisement which this admittedly neglected colony has recently received as a result of the activities of the Colonisation Deputation, which was headed by the Governor, Sir Wilfrid Collet, in bringing prominently before the Colonial and India Offices and capitalists its vast potentialities and the urgent need of population both for the prosecution of existing and the development of new industries. An official pronouncement awaited by colonists generally and information in this connection was forthcoming at the annual session of the Combined Court which was opened recently. We have it on the authority of the Governor that already there is considerable capital in the United Kingdom waiting to be invested in the bauxite industry, as well as the prospect of a very large development in this industry. That the colony has been prolific in bauxite has been demonstrated to the satisfaction both of the local and the Imperial Governments, and it is the policy of the Colonial Office to restrict the granting of licenses for its prosecution to British subjects. Meanwhile the Governor expects to receive at any moment instructions with regard to applications. Closely associated with schemes of industrial development is that of railway extension and construction. In this connection an agreement will be submitted to the Combined Court during the present session for the acquisition of the lines of the Demerara Railway Company, under conditions which the Governor believes "while offering shareholders as good terms as they could have expected will be of benefit to the colony." With regard to the construction of a hinterland railway, in respect of which negotiations are proceeding, His Excellency is very emphatic. "I cannot say whether negotiations will go as far as to render a reference to this Court necessary," he states, "but I wish to declare in the most public manner what in my opinion will be an essential condition in any case of a railway being built in consideration of land grants. The possibility must be borne in mind of the concessionaires finding it unprofitable to continue to work the railway. In such an event the Government must have the power, should it think fit, to work the railway without any liability to pay interest to shareholders or debenture holders, and, so far as I am concerned, it is useless to approach me with any proposition that would saddle the Government with a liability for interest on an unremunerative railway. Given a steady influx of population I believe that a company constructing a railway with a land grant and not looking to an immediate profit might eventually find the undertaking remunerative."—*Reuter's Trade Service.*

## MEETINGS FOR THE WEEK.

*Monday, January* 19.

Royal Society of Arts, 8. (Cantor Lecture). "Aircraft Photography in War and Peace," by Capt. H. Hamshaw Thomas.

*Tuesday, January* 20.

Royal Institution, 3. "Modern Development of the Miners' Safety Lamp," by Sir John Cadman.

Institution of Petroleum Technologists, 5.30. "Spontaneous Ignition Temperatures of Liquid Fuels," by Harold Moore.

Mineralogical Society, 5.30. "Gearksutite at Gingin, Western Australia," by Dr. E. S. Simpson. "Fibroferrite from Cyprus," by C. E. Barrs. "Classification of Meteorites," by Dr. G. T. Prior. "On Torbernite," by A. F. Hallimond.

Institute of Metals, 7.30. (Birmingham Local Section). "Season Cracking," by W. H. Hatfield.

*Wednesday, January* 21.

Royal Society of Arts, 4.30. "Ancient Cottages and Modern Requirements," by Alfred H. Powell.

*Thursday, January* 22.

Royal Society, 3.30. Special General Meeting for the admission of H.R.H. The Prince of Wales. At 4.30, Papers will be read.

Royal Institution, 3. "Renaissance Music in Italy and England," by Richard R. Terry.

Institution of Electrical Engineers, 6. "Transformers for Electric Furnaces," by J. L. Thompson.

*Friday, January* 23.

Royal Institution, 9. "Researches at High Pressures and Temperatures," by Sir Charles Parsons.

*Saturday, January* 24.

Royal Institution, 3. "Aspects of Modern Poetry," by Alfred Noyes.

Institute of Metals, 7.30. (Sheffield Local Section).

[TH]E CHEMICAL NEWS

VOL. CXX., No. 3119.

THE [USE] OF ELECTRICITY IN AGRICULTURE.*

[W]ITH SPECIAL REFERENCE TO ITS DEVELOPMENT IN GERMANY.

By JOHN FRANCIS CROWLEY, D.Sc., B.A., M.I.E.E.

(Continued from p. 28).

[(a)] *Single Winder Ploughing*, complete equipment, con[sisti]ng of one transformer wagon with 75 kva. transformer [10,]000 to 1100 volts, with choking coils, switchgear, [watt]hour-meter, &c., designed for a continuous load. One [win]ding wagon, including one 75 h.p. 1100 volt, 975 re[vol]ution three-phase motor, for a continuous load, with [cont]roller and switchgear, designed for a maximum pull [of 4]000 kgrms.; cable speed 1·6 to 1·1 metres per second; [wag]on speed, 1·4 to 2·1 kilometres per hour, with [acce]ssories. One anchor wagon; 600 metres of 1100 volt [spec]ial flexible cable; one triple pole switch for trans[mis]sion pole. Price, complete, excluding plough, £1550.

[(b]) *Double Winder Ploughing*, complete equipment, [con]sisting of two transformer wagons, each with 75 kva. [tran]sformers 10,000 to 750 volts, with choking coils, [swi]tchgear, watthour-meter, oil, &c., designed for an inter[mit]tent load. Two winding wagons, including two 75 h.p. [750] volt, 730 revolution three-phase motors, for intermittent [loa]d, with controllers and switchgear, each wagon de[sign]ed for a maximum pull of 4000 kgrms.; cable speed, [1·6] to 0·9 metres per second; wagon speed, 1·4 kilo[me]tres per hour. 600 metres of 750 volt flexible cable; [on]e triple pole switch for transmission pole. Price, com[ple]te, excluding plough, £2000.

The only electric ploughing installation in this country [(Se]e *Electrical Review*, Jan. 19, 1916) of which the author [is] aware was one carried out on a farm of 240 acres be[lon]ging to Mr. Chorlton, near Cotgrave, some eight or [ni]ne miles from Nottingham, by Messrs. E. O. Walker [an]d Co., of Manchester. The soil was of heavy clay, [wh]ich would be very difficult to plough by other than [m]echanical means.

*Threshing*.—The driving of threshing machines formed [on]e of the earliest applications of electricity in agricul[tu]re. With the exception of electric ploughing, as regards [m]otor capacity and power consumption, electric threshing [o]ccupies the highest place in purely agricultural work, and [fo]r this purpose motor wagons are largely used, as well as [m]otor trucks and motor sledges.

With the building of long-distance central stations the [a]pplication of the electric motor to threshing machinery [h]as continued to increase, and it may be said that no [f]armer who has once tried electric threshing wishes to [d]ispense with it if electric current continues to be [a]t his disposal.

Threshing in the field furnishes also one of the most [i]mportant uses of the portable transformer in connection [w]ith agriculture. When a greater output is necessary, [a]nd when the distance of the work from the farmyard, [a]nd, therefore, from the fixed transformer which supplies [c]urrent for lighting and power, is too great, the portable [t]ransformer finds a useful opening, and indeed it may be [s]aid that electric threshing plants obtain their full freedom [o]f movement only when such a transformer is available. For this reason many threshing associations in Germany include a portable transformer in their threshing plant [e]quipments, and thus open up the way for the general introduction of electric threshing throughout the country. The employment of a portable transformer enables the farmer to do his threshing at any desired place in the neighbourhood of an overhead high tension line. He thus saves time, as well as horses and workers, and avoids the wastage in carrying the corn for threshing to the yard, and afterwards removing the straw.

With regard to the actual application of the motors to threshing, reference may be made to Fig. 1, where a motor wagon is shown belted to a threshing machine in the field, the current being supplied through portable transformers from an overhead line. In some cases the threshing machine is provided with a "built-on" motor, and in this case, of course, the motor travels with the threshing machine and is not available for driving other machines.

The power taken for threshing depends upon the moisture present and the lengths of stalk. The following table based on actual measurements may be taken as reasonably reliable—

| | Killowatt hours per cent. |
|---|---|
| Rye .. .. .. .. .. | 0·35 to 0·70 |
| Wheat .. .. .. .. | 0·35 „ 0·60 |
| Oats .. .. .. .. .. | 0·25 „ 0·50 |
| Barley .. .. .. .. | 0·30 „ 0·55 |
| Mixed grain .. .. .. | 0·28 „ 0·45 |

The horse-power of the motors required varies from 2 to 6 for threshing machines formerly worked by hand or by haulage animals.

Motors of 20-25 h.p. are used for larger machines with straw presses, and these have a current consumption of 10-12 kilowatts per hour and and an output of 20-30 cwt. of threshed corn.

The horse-power required for a given farm can be easily calculated from the number of acres, an estimate of the corn produced per acre, and the table given above for the units required per cwt.

The following particulars, which are largely based on letters from farmers and reports from public bodies, give some of the advantages of electric driving particularly in connection with threshing:—

1. Low first cost and working costs as compared with steam threshing, especially when the horse-power required is small or the working periods short, and particularly, of course, where a cheap supply of current can be obtained. The saving in energy and expense with the electric motor is shown by the fact that it can be stopped for short periods between work, when coal would have to be consumed in a steam traction engine to maintain steam.

2. The special preparation, such as the heating of the boiler in locomotives, the procuring of water, coal, &c., is not necessary with electric driving.

3. The motor is of small weight, occupies little space, and is, consequently, very portable and available for use at any particular place where it may be required.

4. The motor is adaptable to varied working conditions, for example, to change of weather, as during the rain when the f rm hands cannot work in the fields outside they can be withdrawn for the threshing, which it is understood in this case is carried on in the barn.

5. The simplicity of the control arrangements of the electric motor which are operated by the movement of a handle, handwheel, or something similar.

6. The fact that the efficiency of the motor is independent of its age. An electric motor also works at high efficiency even when the load it is taking is not as high as it is designed to take. This is not the case with steam driving, which practically consumes the same quantity of coal at light load, when driving very little, as it does on full load.

7. Great security against fire, and freedom from any danger of explosion.

8. The uniformity of rotation on the electric motor gives a cleaner threshing, consequently a smaller waste of current, and also a greater output in comparison with other kinds of driving.

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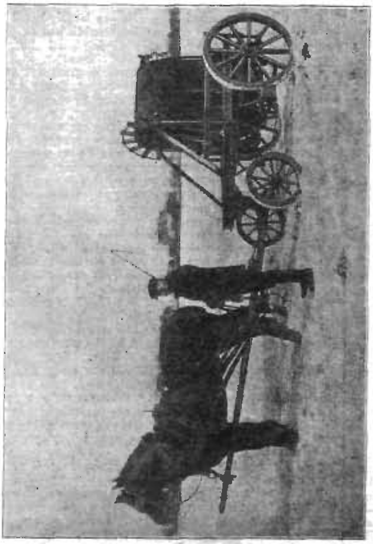

Fig. 4.—Portable Electric Cable Creel.

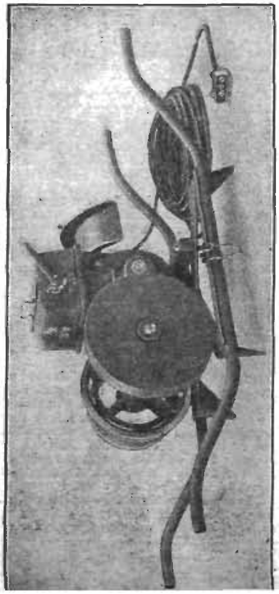

Fig. 5.—Portable Motor Cradle with Self-contained Gear Reduction.

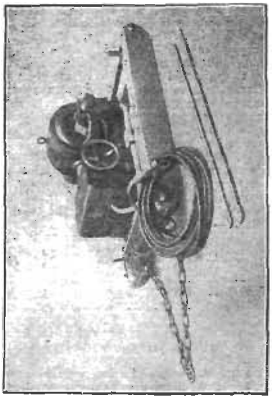

Fig. 6.—Portable Motor Sledge (Motor Protecting Cover removed).

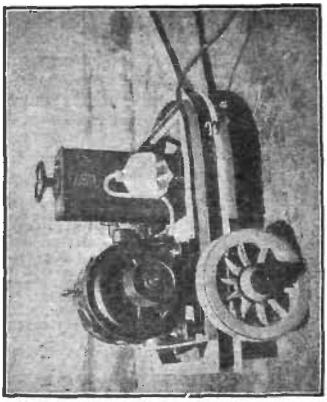

Fig. 7.—Portable Motor Truck (Motor Protecting Cover removed).

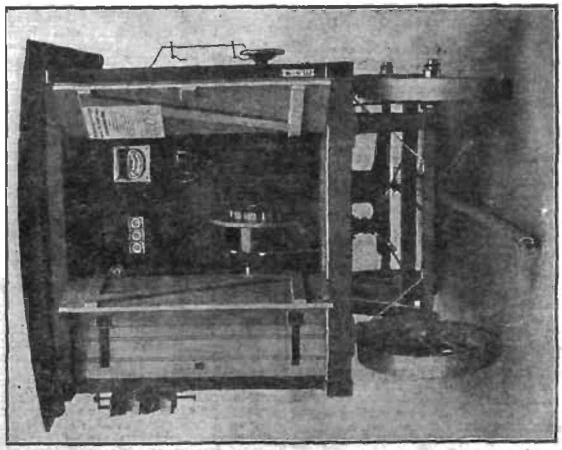

FIG. 8.—PORTABLE MOTOR WAGON, SHOWING CABLE DRUM.

FIG. 9.—ELECTRIC PLOUGHING ON THE DOUBLE WINDER SYSTEM IN PROGRESS.

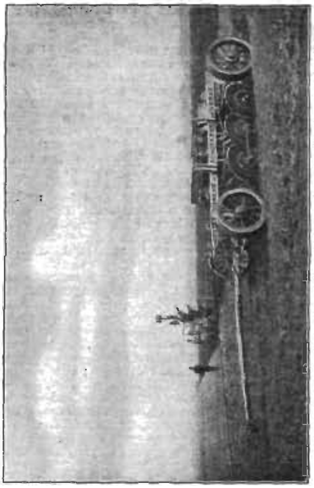

FIG 10.—ELECTRIC PLOUGHING ON THE SINGLE WINDER SYSTEM, SHOWING ANCHORAGE WAGON.

It has been shown by repeated measurements that the saleable corn resulting from electric drive amounts to from 1—1½ per cent more than with the usual steam or other drive employed, due to the more uniform turning moment of the electric motor.

It may also be added that there is no danger incurred by bringing the electric motor close to the fences or sheds, which is not the case with the steam locomotive, petrol engine, or gas engine, as the motor is fully enclosed, and in the larger sizes is carried with all its accessories in a small completely locked wagon, which allows of easy transport and permits the motor to be placed as near as may be to fences, &c., and in any position in the sheds or yard. It can be placed in the barn itself, if necessary.

In reply to a question when giving evidence before the Canadian Committee on Agriculture and Colonisation, a witness said, when referring to electric driving: "You can get a better quality of chaff, it absorbs the moisture from the grain when it is kept for a longer period before threshing; then again, your grain is a better product from leaving it longer in the head. In 1912, three-fourths of the grain in the country was heated because it was threshed too soon, and most of it was harvested wet." (Report of Select Standing Committee on Agriculture and Colonisation, Canada. App. No. 2, 1914).

The cost of an equipment for electric threshing depends, of course, on the size of the threshing machine to be given, and on the accessories necessary. An approximate idea of the cost of the necessary motor wagon may be obtained from the figures already given; thus a motor wagon of 34 h.p. capacity, with accessories, should cost before the war approximately 2500 marks, and allowing 500 marks for the part cost of electrical conductors, &c., they would give a total first cost of 3000 marks exclusive of the cost of the transformer wagon if such were needed. The cost of this would, in any case, in part, have to be charged to other work.

*General.*—For operations on the farm other than ploughing and threshing, portable motors of the type already described are generally employed. Stationary motors are also used where the work is of a more continuous nature. An illustration of a permanent motor driving a model dairy in Canada is given in Fig. 14, the electricity in this case being supplied from the mains of the Ontario Hydro-Electric Commission.

The following figures for power consumption on certain farming operations based on tests give some indication of the costs of performing these operations by electricity.

Chaff Cutting.—A motor of from 2-5 h.p. will cut in an hour up to 20 cwt. of chaff with a current consumption of 0·1 to 0·3 kw. hours per cwt.

For purposes of comparison it may be said that it usually takes one man one hour to cut 1 cwt. of chaff, while two horses and a driver are capable of cutting 3 to 4 cwt. per hour.

Turnip Cutting.—The current consumption for this work varies from 0·01 to 0·02 kw. hours per cwt.

Oat Crushing.—The current consumption for oat crushing is about 0·25 kw. hours per cwt.

Milk Separating.—A motor of 1 h.p. can deal with an output of 2100 litres per hour with a current consumption for skimming, churning, and kneading the butter of 0·25 units per 100 litres.

In forming an idea of the probable cost of current to be consumed by a motor of given size on farm work, it should be remembered that an agricultural load is a very fluctuating one, and for general purposes it is usual to assume that a motor is on full load only during one-third of the working time, and that during the remaining two-thirds of the working time it is only on half load, and it is found in practice that working on this basis gives a fairly good idea of the probable consumption.

In making a comparison between the working cost of driving by electric motor and by heat engines, in addition to the expenditure in coal, petrol, electric current, &c., allowance should be made for interest, depreciation, maintenance, lubrication, and attention, and if these factors are taken into account it will generally be foun that with the smaller motors up to, say, 20 h.p. electric driving is cheaper than any other form of driving wit current at the usual rates obtainable in country districts whereas for outputs of above 20 h.p. the running costs o other forms of power begin to be competitive if the cos of electricity is excessive, particularly if the machine are in continuous service. The low first cost of electrica plant and the discontinuous service required for motiv power in farm work are, however, very much in favour o electrical driving.

The following table gives approximate pre-war costs o the motor cradles, trucks, motor sledges, and moto wagons already described:—

| | |
|---|---|
| Motor cradles up to 3 h.p., including 15 metres of flexible cable—without gear reductions .. .. .. .. .. | 240-550 marks |
| Ditto, with gear reduction .. .. | 350-700 marks |
| Motor trucks or sledges from 2 to 6 h.p., including 20 metres of flexible cable .. .. .. .. .. .. .. .. | 900-950 marks |
| Motor wagons from 10 to 12 h.p., including 20 metres of flexible cable.. | 1400-1500 marks |
| Ditto for 21 to 30 h.p. .. .. .. .. .. | 2200-2400 marks |
| Ditto for 40 to 55 h.p. .. .. .. .. .. | 2900-3550 marks |

(To be continued).

## REPORT OF THE INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS FOR 1919—20.

THE last regular report of this Committee, apart from a annual recommendation to continue the use of the tabl of atomic weights then presented, was published in 1916 The interruption in the series of reports was, of course due to the world's war, which created difficulties of a serious kind among all international organisations. Co operation with Germany became impossible, partly becaus of the difficulty of correspondence and partly because o the personal hostilities created by the conduct of the war There was also an inevitable slackening of scientific activities, and this was well shown by the unusually smal number of new researches in the field of atomic weights Now that peace is in sight, it seems wise to resume th preparation of these reports, even though they may no be for some time quite so truly international as heretofore The determination published since the preparation of ou last report may now be summarised as follows:—

*Hydrogen.*—A very thorough investigation by Burt and Edgar on the volumetric composition of water has given the volume ratio of hydrogen to oxygen as 2·00288 : 1, (*Phil. Trans.*, 1916, 216 A, 393; this research was noted in the previous report for 1917; its review by Guye renders its repetition desirable here). From this value, taking the normal litre weights of oxygen and hydrogen as 1·42900 and 0·089873 grms. respectively, the atomic weight of hydrogen becomes 1·00772, or, rounded off, 1·0077. Guye (*Journ. Chim. Phys.*, 1917, xv., 208), from a discussion of Burt and Edgar's data, accepts this value as lying between the two extremes of 1·00767 and 1·00773. If, however, instead of trusting to the densities of the gases and their physical constants exclusively, we take into account the admirable researches of Morley, Noyes and others, upon the synthesis and analysis of water, the most probable general mean for the atomic weight of hydrogen becomes 1·0078, which differs from the volumetric value by only 1/10000. (Computation by F. W. C). That is, the two distinct lines of attack upon the problem agree within the limits of actual uncertainty. For ordinary purposes the approximate value 1·008 is close enough. It must be remembered that the tables prepared by this committee are for the use, not so much for specialists, as fo

orking chemists in general; and too much refinement 'ill only lead to confusion. No determinations of these r any other constants can be absolute and final. All are ubject to errors which may be reduced nearly, but not nite, to insignificance, but never eliminated entirely. For xample, in the determination of atomic weights from aseous densities it is not possible to guarantee the *bsolute* purity of the gases, or to avoid errors in weighing, i reductions to a vacuum, or in the values given to the hysical constants that are used in the final computations. Some of these errors may be so small as to be negligible, nd in the aggregate they may tend either to reinforce or o compensate one another, but their extreme magnitude an be estimated with some approach to accuracy, and xpressed by means of the usual ± sign. At present an ccuracy to within 1/10000 is the best we can expect to btain. (For an elaborate discussion of sources of error n atomic weight determinations, see Guye and his coleagues—M. Germann, Moles, and Renard—in *Journ. Chim. Phys.*, 1916, xiv., 25, 195, 204; 1917, xv., 60, 360, 405; 1918, xvi., 46).

*Carbon.*—Two investigations on the atomic weight of carbon were reported from the Geneva laboratory in 1918. First, Stahrfoss (*Journ. Chim. Phys.*, 1918, xvi., 175) determined the density of acetylene, ethane, and ethylene. Acetylene proved to be unsatisfactory, because of its tendency to polymerise. From ethane he obtained the value C = 12·006 and from ethylene C = 12·004. On account of some uncertainties in the reduction, he prefers, provisionally, the value C = 12·00.

Secondly, Batuecas (*Journ. Chim. Phys.*, 1918, xvi., 322) determined the density of ethane, and reduced his observations by 3 methods, giving C = 12·005, 11·999, and 11·996. The last two being concordant he regards as preferable, and their mean, C = 11·998, he adopts. It will be remembered that Richards and Hoover, by purely chemical methods, found C = 12·005; and a later combination of all determinations published before 1918 gave the chairman of the committee the mean value C = 12·0025. For ordinary purposes the rounded-off value C = 12·00 may be used, and is so given in the table.

*Bromine.*—Three sets of determinations of the molecular weight of hydrogen bromide have been made in Guye's laboratory at Geneva, by Moles (*Journ. Chim. Phys.*, 1916, xiv., 389; see review by Guye in the same number, p. 361), Reiman (*Ibid.*, 1917, xv., 293), and Murray (*Ibid.*, 1917, xv., 334; Reiman and Murray assume H = 1·008; Moles prefers 1·0076). The acid used was prepared by several distinct methods, and all gave concordant results, which may be summarised as follows, when H = 1·0078:—

| | Mol. wt HBr. | At. wt. Br. |
|---|---|---|
| Moles .. .. .. | 80·9332 | 79·9254 |
| Reiman.. .. .. | 80·932 | 79·9242 |
| Murray.. .. .. | 80·930 | 79·9222 |

These values are wonderfully concordant and the variations are far within the allowable limits of experimental error. In a recent combination, by the chairman of this committee, of all the available data relative to the atomic weight of bromine, the value found was Br = 79·9228, in complete harmony with the Geneva determinations. For ordinary purposes the rounded-off figure 79·92 is enough.

*Boron and Fluorine.*—In a very original investigation Smith and Van Haagen (*Carnegie Inst. Pub.*, 1918, 267) have simultaneously redetermined the atomic weights of boron and fluorine. Their starting point was anhydrous borax, $Na_2B_4O_7$, and their chief difficulty was in insuring the complete dehydration of that compound. The salt was then converted, in a series of successive experiments, into sodium sulphate, carbonate, nitrate, chloride, and fluoride, which gave 8 independent values for boron ranging from 10·896 to 10·905, in mean 10·900. This value was computed with Na = 22·997, Cl = 35·457, S = 32·064, N = 14·010, and C = 12·005. The authors finally discuss all previous determinations and show wherein they were affected by errors. The new value 10·900 should be adopted as the most probable.

In this research sodium fluoride was compared not only with borax but also with the sulphate, and the 8 values found ranged from 19·002 to 19·008, in mean 19·005. The rounded-off value F = 19·0 may be retained for all practical purposes.

*Lead.*—Oechsner de Coninck and Gérard (*Comptes Rendus*, 1916, clxiii., 415) have attempted to determine the atomic weight of lead by calcination of the nitrate, and find Pb = 206·98 when $N_2O_5$ = 108. This determination is evidently of no present value. With this exception the other recent researches relative to this constant have referred to isotopic lead, and the normal element is considered only in comparison with it. Richards and Wadsworth (*Journ. Am. Chem. Soc.*, 1916, xxxviii., 2613), for instance, find for normal lead Pb = 107·183, and Richards and Hall (*Ibid.*, 1917, xxxix., 537) give Pb = 207·187, values slightly lower than the accepted 207·20 as determined by Baxter and Grover. Similar determinations by A. L. Davis (*Journ. Phys. Chem.*, 1918, xxii., 631) gave discordant results. As for isotopic lead its atomic weight is so variable as to show that it is nearly, if not always, a mixture of isotopes, and not a constant which can as yet be placed in the table. The values found have very great significance, but they are far from final. (For discussions regarding the atomic weight of isotopic lead see the Presidential address of Richards before the American Association for the Advancement of Science in December, 1918. Also F. W. Clarke, *Proc. Nat. Acad. Sci.*, 1918, iv., 181).

*Gallium.*—By the analysis of carefully purified gallium chloride, Richards, Craig, and Sameshima (*Proc. Nat. Acad. Sci.*, 1918, iv., 387) find Ga = 70·09 and 70·11. These determinations, however, are only preliminary, but they justify the provisional adoption of the value 70·10. The original values given by the determinations of Lecoq de Boisbaudran vary from 69·70 to 70·12, the last one being very near the new value.

*Zirconium.*—From the ratio between zirconium chloride and silver, Venable and Bell (*Journ. Am. Chem. Soc.*, 1917, xxxix., 1598) find Zr = 91·76. Although this determination is regarded as preliminary, the authors, by pointing out sources of error in all previous values, believe the new one to be the most probable. It seems best, however, to await the complete investigation before changing the value heretofore accepted.

*Tin.*—Baxter and Starkweather (*Proc. Nat. Acad. Sci.*, 1916, ii., 718) by electrolyses of stannic chloride, find Sn = 118·703 when Cl = 35·457. This is in complete agreement with Briscoe's determination, Sn = 118·698. The value 118·70 has already been adopted by the committee.

*Tellurium.*—Staebler and Tesche (*Zeit. Anorg. Allgem. Chem.*, 1916, xcviii., 1) from careful syntheses of tellurium dioxide, find Te = 127·51, which is confirmatory of the accepted value 127·5.

*International Atomic Weights.* (1920).

| | Symbol. | Atomic weight. |
|---|---|---|
| Aluminium .. .. .. | Al | 27·1 |
| Antimony .. .. .. .. | Sb | 120·2 |
| Argon .. .. .. .. | A | 39·9 |
| Arsenic .. .. .. .. | As | 74·96 |
| Barium .. .. .. .. | Ba | 137·37 |
| Bismuth .. .. .. .. | Bi | 208·0 |
| Boron.. .. .. .. .. | B | 10·9 |
| Bromine .. .. .. .. | Br | 79·92 |
| Cadmium .. .. .. .. | Cd | 112·40 |
| Cæsium .. .. .. .. | Cs | 132·81 |
| Calcium .. .. .. .. | Ca | 40·07 |
| Carbon .. .. .. .. | C | 12·005 |
| Cerium .. .. .. .. | Ce | 140·25 |
| Chlorine .. .. .. .. | Cl | 35·46 |
| Chromium .. .. .. .. | Cr | 52·0 |
| Cobalt .. .. .. .. | Co | 58·97 |

| | Symbol. | Atomic weight. |
|---|---|---|
| Columbium .. .. .. .. | Cb | 93·1 |
| Copper .. .. .. .. | Cu | 63·57 |
| Dysprosium .. .. .. | Dy | 162·5 |
| Erbium .. .. .. .. | Er | 167·7 |
| Europium .. .. .. .. | Eu | 152·0 |
| Fluorine .. .. .. .. | F | 19·0 |
| Gadolinium .. .. .. | Gd | 157·3 |
| Gallium .. .. .. .. | Ga | 70·1 |
| Germanium .. .. .. | Ge | 72·5 |
| Glucinum .. .. .. .. | Gl | 9·1 |
| Gold .. .. .. .. .. | Au | 197·2 |
| Helium .. .. .. .. | He | 4·00 |
| Holmium .. .. .. .. | Ho | 163·5 |
| Hydrogen .. .. .. .. | H | 1·008 |
| Indium .. .. .. .. | In | 114·8 |
| Iodine .. .. .. .. | I | 126·92 |
| Iridium .. .. .. .. | Ir | 193·1 |
| Iron .. .. .. .. .. | Fe | 55·84 |
| Krypton .. .. .. .. | Kr | 82·92 |
| Lanthanum .. .. .. | La | 139·0 |
| Lead .. .. .. .. .. | Pb | 207·20 |
| Lithium .. .. .. .. | Li | 6·94 |
| Lutecium .. .. .. .. | Lu | 175·0 |
| Magnesium .. .. .. | Mg | 24·32 |
| Manganese .. .. .. | Mn | 54·93 |
| Mercury .. .. .. .. | Hg | 200·6 |
| Molybdenum .. .. .. | Mo | 96·0 |
| Neodymium .. .. .. | Nd | 144·3 |
| Neon .. .. .. .. .. | Ne | 20·2 |
| Nickel .. .. .. .. | Ni | 58·68 |
| Niton (radium emanation) | Nt | 22 ·4 |
| Nitrogen .. .. .. .. | N | 14·008 |
| Osmium .. .. .. .. | Os | 190·9 |
| Oxygen .. .. .. .. | O | 16·00 |
| Palladium .. .. .. .. | Pd | 106·7 |
| Phosphorus .. .. .. | P | 31·04 |
| Platinum .. .. .. .. | Pt | 195·2 |
| Potassium .. .. .. .. | K | 39·10 |
| Praseodymium .. .. .. | Pr | 140·9 |
| Radium .. .. .. .. | Ra | 226·0 |
| Rhodium .. .. .. .. | Rh | 102·9 |
| Rubidium .. .. .. .. | Rb | 85·45 |
| Ruthenium .. .. .. | Ru | 101·7 |
| Samarium .. .. .. .. | Sa | 150·4 |
| Scandium .. .. .. .. | Sc | 44·1 |
| Selenium .. .. .. .. | Se | 79·2 |
| Silicon .. .. .. .. | Si | 28·3 |
| Silver .. .. .. .. .. | Ag | 107·88 |
| Sodium .. .. .. .. | Na | 23·00 |
| Strontium .. .. .. .. | Sr | 87·63 |
| Sulphur .. .. .. .. | S | 32·06 |
| Tantalum .. .. .. | Ta | 181·5 |
| Tellurium .. .. .. .. | Te | 127·5 |
| Terbium .. .. .. .. | Tb | 159·2 |
| Thallium .. .. .. .. | Tl | 204·0 |
| Thorium .. .. .. .. | Th | 232·15 |
| Thulium .. .. .. .. | Tm | 168·5 |
| Tin .. .. .. .. .. | Sn | 118·7 |
| Titanium .. .. .. .. | Ti | 48·1 |
| Tungsten .. .. .. .. | W | 184·0 |
| Uranium .. .. .. .. | U | 238·2 |
| Vanadium .. .. .. | V | 51·0 |
| Xenon .. .. .. .. | Xe | 130·2 |
| Ytterbium (Neoytterbium) | Yb | 173·5 |
| Yttrium .. .. .. .. | Yt | 89·33 |
| Zinc .. .. .. .. .. | Zn | 65·37 |
| Zirconium .. .. .. .. | Zr | 90·6 |

*Yttrium.*—Hopkins and Balke (*Journ. Am. Chem.* Soc., 916, xxxvi., 2332), by conversion of $Yt_2O_3$ into $Yt_2Cl_3$ nd Yt = 88·9. The ordinary sulphate method is shown be inaccurate. In a later investigation Kremers and opkins (*Ibid.*, 1919, xli., 718) determined the ratio etween yttrium chloride and silver, and found Yt = 89·33. ince this method is the most trustworthy the value given by it should be adopted. The other sulphate determinations are questionable.

*Samarium.*—The atomic weight of samarium has been determined by Stewart and James (*Journ. Am. Chem. Soc.*, 1917, xxxix., 2605) from the ratio between the chloride and silver. The value found is 150·44, which is essentially that given in the table. No change is needed.

*Dysprosium.*—Engle and Balke (*Journ. Am. Chem. Soc.*, 1917, xxxix, 67), by conversion of the oxide into the chloride, found Dy = 164·228. Later, by the same method, Kremers, Hopkins, and Engle (*Ibid.*, 1918, xl., 598) found Dy = 163·83. This discordance, like that already shown for yttrium, led the last named chemists to determine the ratio between dysprosium chloride and silver, which gave 162·52. The earlier method is discredited and the last value, rounded to 162·5, seems to be the one best entitled to acceptance.

*Erbium.*—For this element, by the oxide-chloride method, Wichers, Hopkins, and Balke (*Journ. Am. Chem. Soc.*, 1918, xl., 1615) obtained values ranging from Er = 168·00 to 168·84. The method of determination is thus again shown to be untrustworthy.

*Thorium.*—In a long series of concordant analyses of thorium bromide, Hönigschmid (*Zeit. Elektrochem.*, 1916, xxii., 18) finds Th = 232·152 from the silver ratio and 232·150 from the silver bromide ratio when Br = 79·916. The value Th = 232·15 should be adopted for general use. He also studied thoria from uranium ores, which contained ionium. For this mixture he obtained an atomic weight slightly in excess of 231·50. This may approximate to the unknown atomic weight of ionium.

*Uranium.*—The latest series of determinations of the atomic weight of uranium by Hönigschmid and Horovitz (*Monatsh.*, 1916, xxxvii., 185) was based like their earlier series upon analyses of the tetrabromide. Two sets of analyses were made, one upon a bromide which had been fused in bromine vapour, the other in nitrogen. The value obtained ranged from U = 238·04 to 238·16, the latter being in harmony with their former determinations. The rounded figure 238·2 is given in the table.

*Helium.*—Taylor (*Phys. Rev.*, 1917, x., 653), using the microbalance for determining the density of helium, finds He = 4·0008. Guye (*Journ. Chim. Phys.*, 1918, xvi., 46), in a recalculation of the data, finds He = 3·998. The value 4 should be retained.

*Argon.*—From the density and compressibility of argon Leduc (*Comptes Rendus*, 1918, clxvii., 70) finds A = 39·91. He regards the second decimal as uncertain, and advises the adoption of the rounded value 39·9.

In the above table of atomic weights proposed for 1920, few changes have been made from the values given in the last preceding table. The new values are A = 39·9; B = 10·9; Ga = 70·1; Th = 232·15; and Yt = 89·33. In addition to these the atomic weight of nitrogen should be changed from 14·01 to the more precise value 14·008. The latter figure represents all the best determinations, and is probably correct to within 1 in the third decimal place. For so small a value the change is insignificant.

(Signed), F. W. Clarke,
T. E. Thorpe,
G. Urbain.

—*Journal of the American Chemical Society*, xli., No. 13.

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The white arsenic produced in the United States in 1918 amounted to 6323 short tons, valued at 1,213,000 dols. By far the greater part of the domestic white arsenic consumed in the United States in 1918 was used in preparing insecticides and weed killers, the total quantity so used in 1918 being about 2,000,000 pounds, according to the United States Geological Survey Department of the Interior. Nearly 1,000,000 pounds was used in the glass industry, and a small quantity in the preparation of drugs.—*Reuter's Trade Service.*

# THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ.

(Continued from p. 33).

12. *Electrolysis of Uranyl Acetate Solution.*

THE electrolysis of a neutral solution of uranyl acetate containing 10 grms. of metallic uranium per litre was carried on for one hour at 20° with a pressure of 34 volts and a current density of 1·95 amp. The cathode was rotated, and a porous cup was used as a diaphragm. The cathode was covered with a thin iridescent film that appeared metallic. The porous cup in the meantime had become *partially filled with the yellow oxide of uranium.*

The catholyte was made acid with acetic acid and again electrolysed with 30 volts and a current density of 3·76 amp. *for one hour at a temperature of* 60°. *The electrode* became covered with a slight deposit of the yellow oxide mixed with a thin film quite metallic in appearance. The *catholyte remained acid throughout, and no precipitate of* the yellow oxide appeared under these conditions.

A larger voltage, 85, and a current density of 18·2 amp. gave a *deposit quite metallic in appearance, but con*taminated with a small portion of the oxide. Only a little deposit adhered to the cathode, in quantity insufficient for analysis. The solution soon became heated to boiling, and the larger portion of the uranium precipitated as a mixture of yellow and black oxides. Attempts to keep the solution cool were not successful when high current densities were employed. The temperature was kept below 60° by surrounding the cathode with a glass coil through which cold water could be circulated, and by keeping the electrolytic bath surrounded with a mixture of salt and ice.

Pure metallic uranium could not be plated from an aqueous solution of uranyl acetate even with high current densities. The electrolysis under these conditions always produced a mixture of what seemed metallic uranium mixed with the black oxide. No analysis of the deposit could be obtained.

13. *Electrolysis of Uranyl Salts in Acetone.*

A saturated solution of uranyl nitrate in acetone, when electrolysed with a voltage of 14 and a current density of 0·77 amp. gave a deposit at the cathode of the yellow oxide. The saturated solution of uranyl chloride under the same voltage and current density gave likewise a deposit of the yellow oxide, which sloughed off and piled up below the electrode. When made acid with hydrochloric acid the deposit was the same in appearance, but it dissolved as soon as it fell off. Formaldehyde added to the solution lowered the conductivity but caused the deposit to adhere to the cathode. The deposit was smooth and bronze-like in appearance. On analysis the deposit yielded 46·50 per cent uranium. The bronze colour was due to some organic matter from the formaldehyde and acetone, and the solution had a distinctly caramel odour. No pure metallic uranium was deposited.

14. *Electrolysis of an Alkaline Solution of Uranyl Sulphate.*

A uranyl sulphate solution made alkaline with sodium carbonate was electrolysed with a rotating cathode using a voltage of 6 and a current density of 6·68 amp. at 58° C. The greater portion of the deposit dropped off the cathode, but there was left a small amount, very metallic in appearance, which did not dissolve readily in nitric acid. A portion of the deposit showed it to be the black oxide as usual. The deposit was washed with cold dilute nitric acid, and the insoluble portion dried and weighed. Its weight was very small. It was dissolved in hot nitric acid, and the procedure repeated until the accumulated deposits were large enough for an analysis. The error introduced in this way is great, but this deposit was found to be richer in uranium than previous deposits analysed; 72 per cent of uranium was found.

15. *Electrolysis of Double Potassium Uranyl Tartrate.*

An acid solution of potassium uranyl tartrate containing 5 per cent uranium was made by dissolving potassium uranate in tartaric acid. It gave a poorly conducting solution and deposited a smooth black coat on the cathode. This, like other deposits, was poorly adherent, and the greater portion fell off the electrode. The temperature at the time of electrolysis was 70° and the voltage 19·5, which gave a current density of 5·45 amp. The portion that adhered was dried and analysed. It contained 73·8 per cent *uranium.*

A tartrate solution made alkaline with potassium carbonate was electrolysed with a potential of 15 volts and a *current density of* 19·4 amp. at boiling temperature. Under these conditions a more adherent deposit was formed which on analysis showed 73·5 per cent uranium.

*Another sample prepared under similar circumstance* gave a uranium content of 76·4 per cent. In this run the electrolyte was prepared by dissolving sodium uranate in *sodium acid tartrate. The solution was slightly acid* during the run.

This same solution when made just alkaline with sodium hydroxide and electrolysed with a *potential of 12 volts and* current density of 14 amp. at 76° gave a fairly adherent deposit. It was black with the exception of a few grains that were yellow. The deposit contained 81·5 *per cent* uranium.

With a rotating cathode and a temperature of 80° a voltage of 9·5 and a current density of 7·5 amp., the deposit formed from this same solution was smooth and well adhering while wet. Its colour was black with a slight tinge of brown. When dried with alcohol and ether the brown portion scaled off easily. Analysis showed it to contain 70·8 per cent of uranium.

The same solution electrolysed with a potential of 35 volts and a current density of 35 amp. at a boiling temperature gave a strongly adherent black deposit. This deposit contained 75·8 per cent uranium.

The uranium content of deposits obtained from alkaline tartrate solutions approaches and sometimes exceeds the amount found in the later work with acetate solutions. The products are doubtless the same in general but vary in their uranium content, in the oxygen present, and in the amount of hydration. Pure uranium was not obtained.

16. *Electrolysis of Double Sodium Uranyl Citrate.*

A solution containing 5 per cent uranium was prepared by dissolving sodium uranate in citric acid in the molecular quantity for producing the double salt. It was electrolysed at 80° with a potential of 40 volts and a current density of 12·4 amp. The solution was slightly acid at the beginning but soon became basic. A dense poorly adherent black deposit formed at the cathode but dropped off rapidly. At the same time there was a precipitate of uranic oxide formed. No deposit was obtained uniform enough in appearance to justify analysis. The black deposit was always contaminated with the yellow oxide.

During the electrolysis the anode became bronze in colour. On examination this proved to be carbon contaminated with some uranium salts.

According to Smith (*Am. Chem. Journ.*, 1879, i., 336) a deposit does not form when a double alkali tartrate or citrate is electrolysed, but this is contrary to my experience.

17. *Electrolysis of Uranium Tetrachloride dissolved in Pyridine.*

Since the oxides of uranium are deposited from aqueous solutions of either uranyl or uranous salts it would seem possible to obtain metallic uranium from a solution which

* From the *Journal of Physical Chemistry*, xxiii., No. 8.

mtains no oxygen. A solution of uranium tetrachloride anhydrous pyridine might give the conditions necessary r such an experiment.

*Preparation of Materials.*

Uranium tetrachloride was prepared by passing dry ilorine over an intimate mixture of the green oxide of anium and carbon heated in a combustion tube to about 00°. The uranium oxide was prepared from Merck's ire uranyl nitrate by ignition. The oxide was mixed ith starch paste, and then the starch was carbonised in osed porcelain crucibles. There are formed in the action between chlorine, uranium oxide, and carbon at ast two products and possibly three. The first product imes off at a low temperature, and crystallises in colourss needles on the cooler portion of the combustion tube. t a slightly higher temperature a yellowish green product iblimes. This has all the appearance of anhydrous anyl chloride. The tetrachloride melts around 400° but )es not sublime until heated to 600° and above. It can slowly driven along the combustion tube and eventually aled up in small portions of the tube. It is brown when elted and produces brown vapours when sublimed. On oling the melted product it crystallises somewhat, aving an apple-green mass. In contact with air it mes and gives off hydrochloric acid, and is converted into e more stable salt, $UO_2Cl_2$. Because of this behaviour had to be kept sealed until used, and then handled pidly when required.

Anhydrous pyridine was prepared by distilling pyridine at had been standing for two years over potassium droxide and barium hydroxide. It was distilled under mospheric pressure of 726 mm., and only the fraction at came over between 112·7° and 115° was used.

The anhydrous pyridine was placed in a closed cell, and ire dry hydrogen bubbled through the solution to replace air from the pyridine and cell. The cell and the sealed be of uranium tetrachloride were opened quickly, and e uranium salt was dropped into the pyridine. The retion was not extremely violent, but was accompanied ith evolution of heat, considerable hissing, and the rmation of dense white fumes. At the same time the ridine darkened as though charred, and a greenish black cculent precipitate was formed.

The closed cell was immediately connected with the ttery and the contents electrolysed, while being stirred th a slow current of pure dry hydrogen. The conictivity was poor. 40 volts across the electrodes were cessary to give a current density of 0·14 amp. Within enty minutes the potential had to be increased to 64 lts in order to maintain the current density, and by the d of two hours the conductivity was practically nil.

The deposit was white, tinged with brown, and did not ash off with gasoline. It was placed over calcium loride in an atmosphere of hydrogen until dry. Its tential against uranyl nitrate solution was −0·695 lt.

The weight of deposit obtained in consecutive runs was iall, and analysis of two samples for the uranium connt showed 10·65 per cent and 10·76 per cent of uranium. nother deposit was dried to constant weight and then ated to 120° in a dry test-tube by immersing the tube a bath of paraffin. Pyridine distilled from the solid, id condensed in drops on the colder portions of the tube. he deposit formed was a compound containing uranium id pyridine.

No metallic uranium could be obtained in this way.

18. *Electrolysis of a Solution of Uranyl Tetrachloride in Acetone.*

Renz made use of acetone as a solvent for uranium trachloride in preparing derivatives of pyridine and iinoline (*Zeit. Anorg. Chem.*, xxxvi., 110). This reagent as tried as a solvent from which to plate metallic anium.

The anhydrous acetone was prepared by allowing the commercial product of Mallinckrodt to stand over fused calcium for several days with frequent shaking. The product was distilled and only the portion which came over at 56° used in the experiments.

The solution was prepared by adding anhydrous $UCl_4$ directly to the anhydrous acetone in the electrolysing cell. There was considerable hissing and fuming, and the acetone became blackened. The air was removed from the electrolysing cell with hydrogen as in the electrolysis of the pyridine solution.

The conductivity of the solution was good, but very little deposit of uranium could be obtained. Electrolysis of the solution for periods varying from one and one-half hours to six hours and longer gave only small amounts of deposit. Hydrogen is evolved copiously during the electrolysis and the solution boils. In all the experiments the solvent was returned to the electrolytic cell with a reflux condenser.

The deposits formed were very dark and gave potentials consecutively around the value −0·64 volt. This value for the potential is of the same order of magnitude as that commonly obtained when uranyl salts are electrolysed in aqueous solution. No deposit could be obtained of sufficient weight to justify an analysis for the uranium content.

The solvent was subjected to fractional distillation. The first fraction collected between the temperatures 56° and 60° was pure acetone. The second fraction was principally acetone but contained a little methyl alcohol. This fraction was collected between 60—65°. The third which came over between 65—70° had a different odour. Fraction 1 contained no chlorine, Fraction 2 a slight amount, and Fraction 3 contained a large amount of chlorine. This latter fraction comes over at the boiling-point of 2, 2-dichlorpropane, and while there might have been present some chloroform, tests showed it to be absent. It seems quite probable that the uranium tetrachloride here plays the same *rôle* as phosphorous pentachloride, replacing the oxygen from acetone with chlorine and forming uranium oxychloride, according to the equation—

$$UCl_4 + (CH_3)_2CO = CH_3C\overset{Cl}{\underset{Cl}{<}}CH_3 + UOCl_2.$$

It is quite evident from the abundance of hydrogen obtained that this reaction does not explain all that is taking place. The production of hydrochloric acid would be possible only by the formation of substitution products. The boiling-points of mono- and dichlor-acetone eliminate these as products and chloroform was not found. The only other possibility is the breaking up of the acetone and reduction to carbon by the chlorine present. This would seem to be the case from the deep black colour of the solution.

No pure uranium could be plated from this solution, and all deposits obtained seemed to be nothing more than the oxide usually obtained with perhaps a small bit of uranium. The deposit formed replaced mercury from mercurous sulphate.

19. *Electrolysis of Fused Nitrate Baths.*

Attempts to plate uranium from a fusion of potassium nitrate and uranyl nitrate were not successful. The uranyl nitrate was decomposed with evolution of oxides of nitrogen and formation of potassium uranate. As long as there was present any potassium nitrate the fused mass would conduct, but as soon as the potassium uranate was formed the melt froze and conduction ceased. Examination of the mass around the cathode showed no uranium. There was plenty of the green oxide formed.

The same behaviour was observed with a silver nitrate, uranyl nitrate fusion. There was some conductivity at first, but the melt soon decomposed, leaving the oxides behind. These fused to form some silver uranate. No metal could be detected at the cathode.

20. *Electrolysis of Uranyl Acetate with a Mercury Cathode.*

A 5 per cent solution of neutral uranyl acetate was lectrolysed with a potential of 30 volts and a current lensity of 4·55 amp., using a mercury cathode to see if he metal could be amalgamated with the mercury. The leposit that first comes out of the solution is the yellow oxide. This settles on the mercury, but, of course, does enter into it. On continued running of the current the yellow oxide changes to a darker greenish black, and eventually quite black, in all respects similar to the black deposit formed on platinum from aqueous solutions. Portions of the mercury removed and evaporated left no uranium. The uranium is not deposited from aqueous uranyl solutions as metallic uranium but as the oxide.

20. *Electrolysis of Fused Double Potassium Uranyl Fluoride.*

The electrolysis of a fused mixture of uranium tetrafluoride and potassium fluoride was not successful. The uranium fluoride first melted, and at the beginning conducted the current, but the mass soon froze and could not be melted again. There was a loss of fluorine accompanied with the formation of potassium uranate with high melting-point. No deposit could be found on the cathode that resembled metal.

(To be continued).

## THE BRITISH DYESTUFF INDUSTRY.*

By Dr. HERBERT LEVINSTEIN, M.Sc., F.I.C.

I HAVE been asked to make a few remarks as an introduction to the interesting papers in the "Dyestuffs, Synthetic Drugs, and Associated Products" section, for which a whole day out of the short space of time available for our meeting has been set aside. This procedure, entirely novel in the history of the Society, shows the importance attached by the Council of the Society to the organic chemical industry, of which the dyestuff industry is the predominating partner.

My one regret is that it is I who am addressing you and not my father, who, had he lived, would undoubtedly have been in my place to-day. Twice president of our Society, it is entirely due to his long and courageous battle for patent law reform that the country was able to have supplies of vital commodities such as indigo and hydrosulphite during the war. To him was due as much as to any one man that our aniline dye industry was kept alive, and I am sure that this Society, of which he was an original member, and for which he worked so assiduously for many years, first as chairman of the Manchester section and then as a member of the Council, will share my regret.

I shall not give you a panegyric on the war work of the British dye industry, though this was quite remarkable. Such reviews have a tendency to make one complacent and to encourage the fatal notion that we can for the moment relax our efforts.

Nor do I propose to say anything about our present position and future intentions, save this:—

The industry now operates on a large scale, for the British Dyestuffs Corporation, the principal manufacturer, already employs close on 7000 persons and some 300 academically-trained chemists exclusively in the manufacture of dyes and auxiliary products, and their works comprise about 1050 acres.

Further large extensions are in preparation both to research laboratories and plant, and I anticipate that before the end of this year the number engaged will be substantially increased, with a corresponding increase of output. The range of products manufactured is being enlarged as quickly as new construction permits. Our immediate object is to manufacture, in the shortest space of time, a range of dyes sufficient to render the country substantially independent of German dyes.

As the Government, who have a substantial holding in the British Dyestuffs Corporation, have in many ways shown their determination to secure a dye industry here, it is important that everybody should thoroughly understand the facts which make a successful dye industry of paramount importance to the State. Mr. Runciman realised this in 1915, and his two successors in office, Sir Albert Stanley and Sir Auckland Geddes, have both been greatly interested in the industry, and have done much to encourage those engaged in it under great difficulty. I propose, therefore, to deal with those aspects of the dye industry which explain why any British Government may well feel uneasy until we possess a dyestuff industry equivalent to that of Germany.

*Reasons why a success of the Dye Industry is vital to the State.*

There are four reasons why the success of the dye industry is vital to the State. I do not give them in their order of importance; there is no order of importance. Each reason is in itself adequate.

(1) *A Key Industry.*—The dye industry is a key industry—an overworked word which now conveys nothing to a good many people. Mr. Runciman gave a clear explanation in stating the reasons for the formation of British Dyes, Ltd., during his tenure of office. (House of Commons, November 27, 1914.)

"Though it is perfectly true that the whole of the textile industry is not dependent upon dyestuffs, we do know that the combined capital of such operations of textile and other industries which require aniline dyes comes to no less than £200,000,000 . . . about 1,000,000 of our employees ar[e] either directly or indirectly interested in the adequat[e] supplies of dyestuffs for their main industries."

(House of Commons, February 22, 1915.) "This is no[t] a mere matter of one corner of one industry; it is a matte[r] of vital concern, not only for our textile industry, but of [the] whole group of industries which are dependent upon th[e] use of colours. Wool and cotton are indeed importa[nt] enough, . . . but there are other industries which, li[ke] wool and cotton, are dependent upon the use of dyes, a[nd] mainly aniline dyes. The lace industry of Nottingha[m,] the silk industry of Macclesfield and elsewhere, the cott[on] industry, the making of paints, such small things as in wall-papers, the colouring of leather goods, the colourin[g] of hats, and I would add, too, the colouring of some food[s;] they all depend upon an adequate supply of dyestuffs. [It] may be that some of these industries can dispense alt[o]gether with the use of dyes; but the textile industry a[nd] some others, like the carpet and linoleum trades, a[re] absolutely dependent upon aniline dyes if they are [to] succeed."

(On November 27, 1914.) "No one can tell what exac[tly] will be the position after the war is over. Of this I [am] certain: if we go on being dependent in a large porti[on] of our textile trade, whether cotton or wool, upon suppl[ies] which Germany has the power to cut off whenever [she] pleases, we leave these cotton and wool industries in a st[ate] of peril."

It may be said against Mr. Runciman's view that [the] textile trades did exceedingly well up to the time of [the] war, though dependent upon Germany for a supply of th[eir] products, and that now that the war is over there is not [the] same necessity for rendering ourselves entirely independ[ent] of Germany for the supply of dyestuffs.

That view would be, however, entirely erroneous. I[t is] held by no one who is at all familiar with the methods [and] history of the big German aniline dye trust, which [was] created in 1915. The negotiations for the gigantic c[om]bine were well advanced in August, 1914, and [its] conclusion was not, as is generally supposed, due to [the] war, but the carrying out of a policy long decided u[pon]

* A Paper read before the Conference on Dyestuffs, Synthetic Drugs, and Associated Products, July 17, 1919.

Had the war come but a little later the ring would have been closed, and our textile industry would have appreciated an acute difference in the conditions under which they would have received their supplies. To-day this trust, familiarly known as the I.G., is the most powerful weapon possessed by the Germans, for in peace, as in war, it was and is a tool of the German Government.

It is inconceivable that we should voluntarily permit the I.G. to dictate to essential industries the terms on which *they should obtain their dyes; that we should leave to the* I.G. the power to withhold supplies of useful or even essential commodities, or to charge British consumers a higher price than they charge their own textile trades. That, however, would have been the position of this country but for the war, and would have been the situation to-day but for the extraordinary efforts made during the war under the greatest possible difficulties to create a strong dye industry here. If these efforts are not successful, the textile industries are not safe. The real danger of being dependent upon Germany for dyestuffs did not lie in the risk that we might be cut off from supplies in the case of a war with Germany, but that the world monopoly possessed by Germany in dyestuffs was imperceptibly be*coming a desperate menace to the freedom of our textile* trades. It is of the first importance that this should be universally recognised. It is the main reason, apart from powerful sentimental considerations, which has made the dye consumer so enthusiastic a supporter of our industry since the war. It was ignorance of this vital fact, because the I.G. was inchoate and still concealed its character, and not indifference to it, which made him appear lethargic in assisting British dye manufacturers before the war.

(2) *National Security as a Guarantee of Peace.*—The dye industry is required for national defence as a guarantee of peace. I invite you to consider the war record of the German combine.

During the war the I.G. produced not only all the synthetic ammonia and nitric acid needed for the production of explosives and also vast quantities of explosives, but also, with an unimportant exception, the *whole* of the chemical warfare products used by Germany in the course of the war.

It was entirely due to the I.G. that Germany was able, in spite of the blockade, to carry on the war after the end of 1915. Consider what this means. But for the possession of her dye industry, on which the General Staff did not even rely for munitions in 1914, the German resistance would have broken down in little more than a year for lack of nitric acid.

Can anything more clearly prove the military value of the German dye industry and the loss and destruction which it has caused us?

Apart from the production of nitric acid, oleum, and high explosives, the German dyestuff plants are of supreme importance for chemical warfare, because they are extraordinarily adaptable. Practically any organic product can be manufactured in them.

This is due partly to standardisation, but chiefly because the plant is often designed, not for the manufacture of *specific substances, but for the purpose of carrying out* specific chemical operations. It was for this reason that most of the poison products used by the Germans were not made in one factory. Certain operations were carried out in one factory; other operations could be carried out very conveniently in another plant. Thus, in the case of mustard gas, thiodiglycol was prepared at Ludwigshafen, and the mustard gas itself at Leverkusen. The reason for this was that at Ludwigshafen there was already in existence plant which could be used for the manufacture of thiodiglycol.

Where extensions were put down for the manufacture of *poison gas the reverse holds good. The extensions for the* purpose of war were adaptable for the purpose of peace.

The Germans were, of course, fully conscious of this, and far the greater part of their war expenditure *on* chemical plant was of a permanent character, and erected with a view to the after-war commercial struggle. The plant erected in Germany for the increased production of mustard gas is now available for the increased production of dyes.

Attached to one of their plants erected during the war, ostensibly solely for the purpose of war, are laboratories which contain a large luxuriously-equipped lecture room, and cost £200,000.

One may sum up the situation in this way:—

(1) The production of explosives in blockaded Germany *was possible only owing to the Haber process belonging to* the I.G., which was greatly developed by them during the war.

(2) Each factory of the I.G. is either an arsenal or a potential arsenal of great size, capable of making great quantities of intermediate products and dyes one day, and twenty-four hours later capable of being switched on to the manufacture of stupendous quantities of poison gas.

The military value of chemical warfare is little understood owing to the secrecy in which the work has been done; but we must not, therefore, underrate its importance.

Gas warfare resolved itself into a contest between the development of gas defence (*e.g.*, the gas mask) and the *discovery of new gases which would penetrate the gas* defences. Everything depended upon surprise, and a surprise, to be effective, means the provision of large quantities of material. In our own country, when a new gas had to be made *ad hoc*, plants had in nearly every case to be erected. This involved great delay before the product could be used in the field, and these plants are valueless for peace purposes.

In Germany the I.G. took charge of the whole manufacture, and produced the material for use in the field in a much shorter time. Their plants are of great peace value.

If Germany were to remain the only country possessing such factories she would have every inducement to use them for aggression, for she would have no cause to fear reprisals. She might conceivably be certain in her own mind of effecting a strategic surprise. Therefore, the establishment of plants of equal magnitude in this country on a sound basis is one of the first guarantees of peace.

Let me read to you a passage from President Wilson's address to Congress, telegraphed from Paris on May 16, for, coming from President Wilson, the words have peculiar significance: "The German chemical industry with which we are brought into competition was, and may still be, a thoroughly-knit monopoly capable of exercising competition *of a peculiarly insidious and dangerous kind.*

"The close relation to the manufacture of dyestuffs on the one hand and explosives and poison gases on the other hand, moreover, has given the aniline dye industry exceptional significance and value. Although the United States will gladly and unhesitatingly join in the programme of any national disarmament, it will nevertheless be a policy of obvious prudence to make certain of the successful maintenance of many strong and well-equipped chemical plants."

The words coming from this source are indeed signifi*cant. Yet the danger to America is less than to us by* the three thousand miles which separate her from the banks of the Rhine.

I do not agree with what *my friend*, Sir William Pope, said in his powerful presidential speech to the Chemical Society on March 27, 1919, with regard to the production of mustard gas. I say this not for the purpose of controversy, but because it is important that the facts should be correctly appreciated, as they have a bearing on policy and on the question of the importance of the dye industry for national defence. Sir William Pope states that the method of manufacture of mustard gas employed in this country was thirty times as effective as that of the Germans, and the cost in Germany was thirty times as great as that of our product. *I am well acquainted with the German* method, and also with our own, for it was worked out in our laboratories by the head of our research department,

1. It would be madness after the close of this terrible war, fought to secure our ideals of political freedom, not to make ourselves economically free from Germany.

2. It would be folly to leave Germany the sole possessor of factories, potential arsenals, which, because they were unique in the great war, enabled her to carry on this war for three additional dreadful years.

3. It is impossible for us to maintain our commercial supremacy if we throw away the one chance of organising the inventive talent of our chemists.

I commend these propositions to all persons if there be any such who question the paramount importance of securing a firm, large, and flourishing dye industry in our country for the protection and development of the vast interests of the Empire. It is, I believe, demonstrable that if Germany retains her predominance in Europe in the dye industry she will ultimately win the war, for though the campaign is gloriously ended, the war is not over nor the victors certain. Though the German military defeat is complete, they may yet regain through their dye industry their former ascendancy over Europe.

Germany recognises this fact, and is straining every nerve, using every device, to re-establish her commercial dominance in the dye industry. Her propaganda is to be seen in the press, and not only in the German and neutral press. It is of the utmost consequence that these simple incontrovertible facts with regard to the importance of this industry should be brought thoroughly home to the people of this country.

*Conclusion.*

It follows from what I have said that enormous responsibility rests upon the chemists of this country, and I think that it is fully appreciated. During the war our chemists rendered good service and made sacrifices and ran risks as has been handsomely recognised in particular by Mr. Kellaway.

But let us be quite clear on this. The real burden of the war was not borne by chemists, and the victory was not won by chemists or by engineers, but by the indomitable courage and tenacity of our soldiers. The real war work of our chemists lies yet before them, for it rests with chemists to secure in the next few years the opportunities the soldiers won for us, the fruition of which German chemists may yet deny us.

In the final stage of the struggle, in which the clash of arms was but the first round, the chemist's work will be a decisive factor. If the chemist is to take his rightful place as a leader in our industrial order, he must be the first to emerge from the wave of war-weariness and work-weariness which threatens to engulf us.

There is a great opportunity in this for chemists. Let us take it greatly.

The Chairman said that the report of Mr. Palmer referred to by Dr. Levinstein had actually been written by Mr. J. H. Choate. It was an extremely valuable account of the history of what the Germans had done, not merely during the war, but prior to the war, in order to establish themselves in America, not only as regards industry and commerce, but also more particularly in the matter of diplomatic advantages.

Royal Institution.—On Tuesday next, Jan. 27, at 3 o'clock, Prof. G. Elliot Smith begins a course of three lectures on the "Evolution of Man, and the Early History of Civilisation." On Saturday, Jan. 31, Sir Frank Watson Dyson, the Astronomer Royal, delivers the first of three lectures on the "Astronomical Evidence bearing on Einstein's Theory of Gravitation"; and on Thursday, Feb. 5, Prof. A. E. Conrady commences a course of two lectures on "Recent Progress in Applied Optics." The Friday Evening Discourse on Jan. 30 will be delivered by Mr. S. G. Brown on the "Gyrostatic Compass," and on Feb. 6 by Sir Walter Raleigh on "Landor and the Classic Manner."

## MEETINGS FOR THE WEEK.

*Monday, January 26.*

Royal Society of Arts, 8. (Cantor Lecture). "Aircraft Photography in War and Peace," by Capt. H. Hamshaw Thomas.

*Tuesday, January 27.*

Royal Institution, 3. "The Evolution of Man and the Early History of Civilisation," by Prof. G. Elliot Smith.

Institution of Civil Engineers, 5.30.

Royal Photographic Society, 7. "Life on the Gold Coast," by Major W. Bladon.

*Wednesday, January 28.*

Royal Society of Arts, 4 30. "The Ruin and Restoration of Belguim," by Sir Cecil Hertslet.

*Thursday, January 29.*

Royal Society, 4.30. "The Genetics of 'Rogues' among Culinary Peas (*Pisum Sativum*)," by W. Bateson, F.R.S. "Studies on Synapsis—I. Oogenesis in the Hymenoptera," by L. T. Hogben. "On a Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours," by H. Onslow.

Royal Institution, 3. "Renaissance Music in Italy and England," by Richard R. Terry.

Institution of Mechanical Engineers. Cardiff, at 6. Manchester at 7.

*Friday, January 30.*

Royal Institution, 9. "The Gyrostatic Compass," by Sidney G. Brown.

*Saturday, January 31.*

Royal Institution, 3. "The Astronomical Evidence bearing on Einstein's Theory of Gravitation," by Sir Frank W. Dyson.

Assistant Chemist required. Thoroughly experienced in Analysis of Iron and Steel Works Materials. State experience and salary required.—Address, F. E., Chemical News Office, 16, Newcastle Street, Farringdon Street, London, E.C. 4.

Assistant Chemist required for Analytical and Research Work in connection with Iron and Steel manufacture. Thorough training in Chemistry and Physics essential. State age, experience, and salary required.—Address, "C.I 2," Chemical News Office, 16, Newcastle Street, Farringdon Street, London, E.C 4.

General Manager wanted for large Cement Works in India. Must be fully qualified Mechanical Engineer, preferably with experience in the management of Cement Works, and be able to supervise construction. Salary up to 1500 Rupees per month for suitable man. Three years' agreement will be entered into, with passage out and home, unfurnished quarters, light, fuel, and electric fans will be supplied free.—Address, "C.W. 15," Chemical News Office, 16, Newcastle Street, Farringdon Street London, E.C. 4.

Wanted, Junior Analyst to assist in the Examination of Raw Materials and General Stores in Laboratory of large Works near London. Applicants must have had previous experience and be trained competent Analysts. State experience and salary required.—Address, P.B., Chemical News Office, 16, Newcastle Street, Farringdon Street, London, E.C. 4.

FOR SALE.— Second-hand CHEMICAL APPARATUS of small Laboratory. Send stamped envelope for list. Also old JOURNALS OF CHEMICAL SOCIETY, 1900-14, bound in cloth by Publishers, 1915-19 unbound; all new and complete. What offers ?—Address, C. J. R., Chemical News Office. 16, Newcastle Street, Farringdon Street, London, E.C. 4.

WANTED TO PURCHASE.

JOURNAL OF CHEMICAL SOCIETY, 1870-1906.—Priced offers to W. M., 114, Delaware Mansions, London. W. 9.

THE CHEMICAL NEWS
VOL. CXX. No. 3120.

26 FEB 1920
COIMBATORE

THE

# USE OF ELECTRICITY IN AGRICULTURE.*

## WITH SPECIAL REFERENCE TO ITS DEVELOPMENT IN GERMANY.

By JOHN FRANCIS CROWLEY, D.Sc., B.A., M.I.E.E.

(Continued from p. 40).

*Conclusion.*

THE *following abstracts from a recent important report* should show that German agriculturists had faith in the claims they made for electric power and lighting on the farm. (Report to Board of Agriculture and Fisheries, by J. H. Cabell, 1913). The writer states that "the use of electric light and power has spread with striking rapidity in the agricultural districts of Germany in recent years." And he adds the further statement that in "Saxony electricity was used to a far greater extent by small and medium holders than by large holders."

The most striking lesson we can draw, however, from a study of the application of electricity to agriculture in Germany lies in the manner in which the thinly-populated rural districts secured the advantages of a cheap supply of electricity. This was done in the main through rural co-operative societies, and the growth of these societies in recent years reads almost like a romance. In 1901 there was one such society; in 1909, 82; on January 1, 1910, 157; on January 1, 1911, about 340; and in 1913 the number had increased to between 600 and 700, or more than the total number of public electricity supply undertakings in the United Kingdom.

Some of these societies produced electricity themselves; some bought electricity in bulk, and distributed it over their own distribution system; while others still only combined to guarantee a certain consumption, and thus secure cheap current from the supply authority.

It is worthy of note that in remote districts where the erection of a central station might not be justified, the societies sometimes purchase surplus power from private undertakings which manufacture electricity for their own use.

In this country, which is comparatively thickly populated, and where the distances to be traversed are not so great, the provision of electricity in rural districts is a much simpler undertaking than its provision in the rural districts of Germany, and the author feels that if steps were taken to promote a co-operative movement in this country for the supply of electricity in these districts considerable progress would be made.

There are over 428,000 farms of from 5 to 300 acres each, and averaging 60 acres, in the United Kingdom, and it is estimated that to operate these electrically would consume not less than 4,000,000,000 units per annum, or as much as is generated altogether by the whole of the electricity supply undertakings of England and Wales. This in itself is a striking fact, and indicates to some extent the importance of this load from the point of view of the supply authorities.

Apart altogether from the question of electricity supplies, much has been achieved in many districts in Germany by combination among the farmers, and the interests especially of the small and moderate landowners have been substantially advanced by means of the co-operative system. In these countries co-operation might even go further than in Germany, and provide the portable electrical apparatus necessary for use at the farm, this being passed on from farm to farm as the work is completed, as is at present done with threshing machines. A considerable future should lie in front of co-operative endeavour of this character.

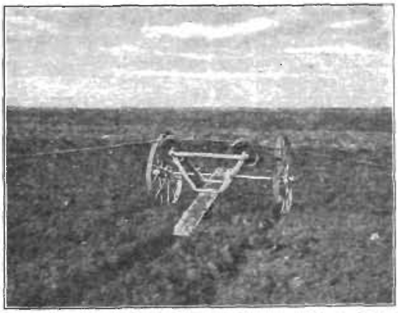

FIG. 13.—ELECTRIC PLOUGHING ON THE SINGLE WINDER SYSTEM, SHOWING CABLE GUIDING CARRIAGE.

The problem is of interest, too, to the manufacturer of electrical machines, and unless some steps are taken to meet the growing demand for machines designed for the technical conditions of agricultural work, the country will lose a good deal of this type of business abroad. In the Argentine, Australia, Canada, and Russia, not to mention China, there are many millions of acres that will need cultivation and transport facilities in the immediate future, and the provision of the necessary equipment is work one would like to see done here. In this connection we may recall the very considerable assistance the Royal Agricultural Society gave in the development of the steam plough, and also in the development of the internal combustion engine, particularly through the trials held at the Society's shows and the valuable prizes offered for the best designs of apparatus.

It would not be easy to over-estimate the help similar

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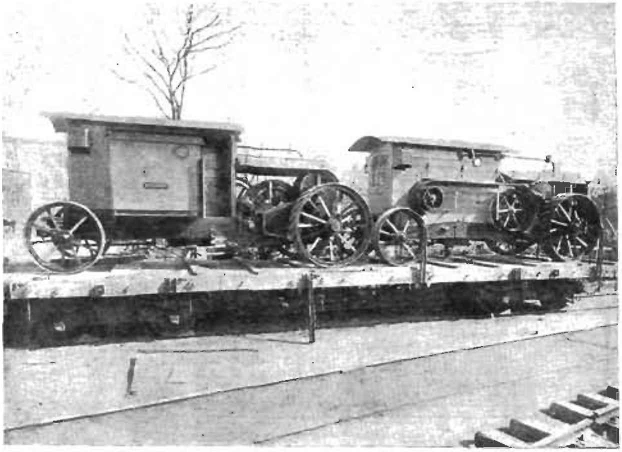

FIG. 11.—WINDING WAGON IN TRANSIT ON RAILWAY TRUCK (Double Winder Ploughing System).

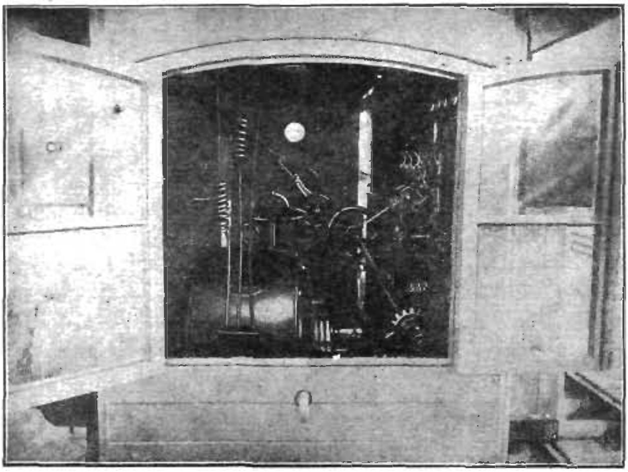

FIG. 12.—ELECTRIC PLOUGHING, SHOWING INTERIOR VIEW OF WINDING WAGON.

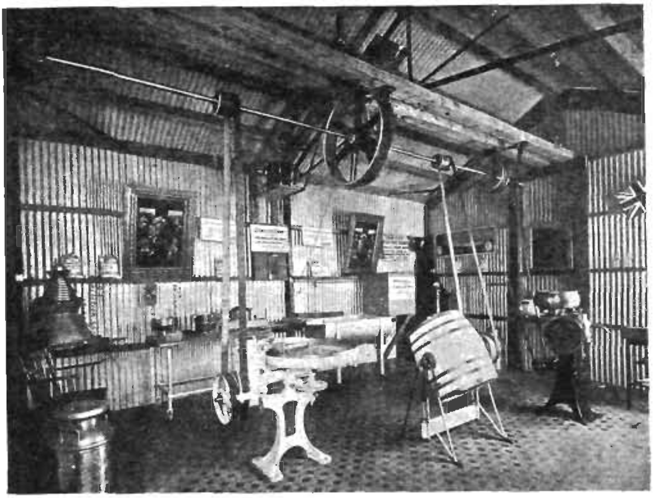

Fig. 14.—A Stationary Motor in a Model Dairy in Canada.

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Fig. 15.—Electricity applied to Agriculture in Canada. Demonstration Lorry (from left to right, Cream Separator, Milking Machine, Grinder, and Circular Saw).

trials and prizes for the best design of portable electric transformer wagons, portable cable creels, portable motors, &c., would give in the development of electricity applied to agriculture, and it is to be hoped the Society may see its way to do something in this direction.

Demonstration wagons also, such as that illustrated in Fig. 15, which is one of two wagons sent into rural districts by the Hydro-Electric Commission of Ontario to illustrate "the use of electric power in the household and its application to the driving of farm machinery," would do much to familiarise the farmer with electric driving and its advantages.

As showing the relative positions of German and British agriculture before the war, the following may be quoted from a recent memorandum. ("The Recent Development of German Agriculture," by T. H. Middleton, C.B., 1917. Cd. 8305). On each hundred acres of cultivated land:—

1. The British farmer feeds from 40 to 50 persons, the German farmer feeds from 70 to 75 persons.
2. The British farmer grows 15 tons of corn, the German farmer grows 33 tons.
3. The British farmer grows 11 tons of potatoes, the German farmer grows 55 tons.
4. The British farmer produces 4 tons of meat, the German farmer 4½ tons.
5. The British farmer produces 17½ tons of milk, the German farmer produces 28 tons.
6. The British farmer produces a negligible quantity of sugar, the German farmer produces 2¾ tons.

Many causes contributed towards the superiority of the German agriculturist, first among which must be placed the increase in the use of artificial fertilisers, which rose between 1890 and 1910 from 1,600,000 to 6,000,000 metric tons. Some credit must, however, be given to the increased use by the farmer of the mechanical aids to husbandry, to some of which it has been the object of this paper to draw attention.

It was stated in a recent publication (the *Vulcan*, New York, Vol. I., No. 3, November, 1917) that "food shortage, greater production, scarcity of labour, increased efficiency, freight congestion, priority of shipment, high prices, and economy in delivery . . . are a few of the things that will compel the farmer to turn to mechanical power." A study of the application of electricity to farm work in Germany seems to the author to show that the farmer in this country will be wise if he carefully considers the claims of electricity before he adopts other methods for providing the mechanical power he will undoubtedly need in the future.

The writer wishes to acknowledge his indebtedness to Mr. A. M. Morrison, B.Sc., for considerable assistance in the preparation of the description of the machines in use in Germany, and to Messrs. Siemens Brothers Dynamo Works for placing the technical information in their possession at his disposal.

(To be continued).

Co-Partnership for Road Transport.—The National Council of the Commercial Motor Users Association (Incorporated) will, at its meeting in London on February 4, devote a special afternoon session to the discussion of co-partnership and profit-sharing schemes in relation to the road-transport industry. The Chairman of the Association, Mr. E. S. Shrapnell-Smith, C.B.E., has written a special article on the subject, inclusive of summaries of representative schemes, and this has been circulated in pamphlet form to the whole membership of the Association, representing owners of some 40,000 commercial motors throughout the country. The contents of the pamphlet constitute a strong case for the adoption of co-partnership principles, of which the author declares himself to be a convinced supporter.

## NOTE ON LIGHT FILTERS FOR THE MICROSCOPE AND PHOTOMICROGRAPHY.*

By J. William Gifford.

As far back as 1894 it was found that a solution of malachite green in glycerin absorbed all the visual spectrum except a broad band in the region of the F line of the solar spectrum and a narrow red band near B (*J.R.M.S.*, 1894, pp. 164-7), and that such a solution placed in a glass trough was eminently effectual as a light filter for microscopic use, especially when the red band was removed by inserting a piece of signal green glass into the fluid.

The year following, a screen similarly constructed, but with a solution of methyl violet for use in photomicrography, was described (*J.R.M.S.*, 1895, pp. 145-7) In recent years it has been found that peacock green glass possessed the same properties as signal green to a greater extent, and the use of the latter has therefore been dropped.

Instead of the glass trough with the signal green placed in it, the form these light filters have recently taken is as follows:—Discs of peacock green glass about 0·06 in. thick and of diameter to fit into the substage condenser are cut out. On these discs are built up cells, using gold size and soft metal rings, or the former alone, just like those made for mounting microscopic objects in fluids. If a metal ring is used, then a coat of size must be given to the top of it and be allowed to dry. Then a final coat must be placed on that and allowed to get tacky. Then place rather more than sufficient dye solution in the cell near the edge. The glycerin will cause it to stand up beyond the top of the cell. Take a clean glass cover, make contact with the tacky gold size at a point nearest the drop of dye. The point of contact will act as a hinge. Now allow and assist the cover to fall until in contact with the gold size all round the ring. While the cover is falling and this contact is extending, the dye solution will flow forward and out in a wave. When contact is made with the top of the cell all round, take any blunt instrument and press the cover down in the middle until still more dye flows out. While this is being done adjust the cover on the ring if necessary by the direction of the pressure. Quite a considerable pressure may be used; cover glasses are very flexible. When enough dye has passed out to leave the cover slightly concave, and you are assured that the adjustment is correct, suddenly remove the pressure. Pneumatic action will at once take place, owing to the resilience of the indented cover, and the edge of the latter will adhere so tightly to the gold sized ring that it is possible to wash under the tap with a full stream of water at once. If made as described, the cell will not give out. Light filters made in this way are shown; one of them has been made and used for twenty years.

## GLASS FOR OPTICAL PURPOSES.*

By Dr. W. E. S. Turner, D.Sc., M.Sc., of the Department of Glass Technology, Sheffield University.

I should like to make some remarks of a very general character to indicate to makers and users of instruments the position in which optical glass makers frequently find themselves. There is, in my mind, not the slightest doubt that we can produce in this country all the types of glass requisite for microscopes and other optical instruments. The long experience of Messrs. Chance Bros. and the splendid achievements of the new Derby Crown Glass Company undoubtedly demonstrate this.

The amount of optical glass in any one instrument is, as a rule, quite small, whilst for the instruments of high precision the total amount of glass called for by manufacturers

* Read at the Joint Meeting of the Faraday Society, Royal Microscopical Society, and Photomicrographic Society, Jan. 14, 1920.

also small. The glass maker, however, knows that in der to ensure homogeneity, freedom from striæ, &c., m the glass he must make a melt on a considerable ale. Further, some designers of optical instruments ill call for a new glass of special properties; may be, for ample, one which is successful in eliminating light rays tween certain wave lengths. The production of such a ass calls for considerable research on the part of the lass manufacturer, and he usually cannot expect to sell at a very small quantity when produced, whilst the strument maker is not prepared to cover the cost. Such demand cannot always be met by the glass manu cturer; it is in no sense a commercial proposition. For me reason, connected probably with the early days of erman competition, the manufacture even of the well nown varieties of optical glass has never been re unerative, although with the recent American products e prices, I believe, have had a more reasonable relation the cost,

There is an obvious remedy for the unremunerative ates for optical glass, and instrument makers should be repared to pay more. There is also a means by which pecial glasses required only in small quantities at the xpenditure of much time by glass firms as well as nancial loss may be made. It lies in the use of the joint esources of the laboratories of the British Optical Instru ent Manufacturers' Research Association under Sir Herbert Jackson and of the Department of Glass Tech ology in the University of Sheffield.

The last-named institution has been equipped in such a nanner as to be admirably adapted for making special glasses in smaller quantities than the manufacturer can consider worth while, and meltings up to 2 cwt. in size can e undertaken. Where it is a matter of importance that special glass shall be worked out, I urge most strongly hat the joint resources of the two laboratories be em loyed.

In regard to crystals of calcium fluoride, I heartily concur with Sir Robert Hadfield's views that it would be strange if the mineral resources of the Empire could not furnish our requirements. Some time ago I received from a merchant, Mr. B. Moss, 21, King Street, Covent Garden, London, W.C., a beautiful specimen of crystalline calcium fluoride from a mine in the neigbourhood of Johannesburg. I am forwarding specimens of this to you. When I say that the specimen was sent with the object of obtaining a market amongst manufacturers of common glass articles only, it will be agreed that the source may be worth further exploitation for optical specimens.

The manufacture of optical glass in America, taken up only during the war, is still a long way behind ours in output and variety. Recently I was able to visit practically all of the war plants. The number of types made so far is limited, and in the last few months all the plants, except that of the Spencer Lens Co. at Hamburg, New York, and the new experimental plant at the Bureau of Standards, Washington, have closed down. For a long time, therefore, there should be in America an important market for optical glass made in this country.

## REVIEW OF THE SPELTER SITUATION.

By H. M. RIDGE

In 1913 the world's spelter production amounted to 982,000 tons, of which 32 per cent was made in the United States, 28 per cent in Germany, and 20 per cent in Belgium. In Great Britain only 6 per cent was made, although the consumption amounted to 23 per cent of the metal produced in the whole world, while in the whole of the rest of the Empire only 3700 tons was produced. As a consequence an acute shortage of metal was experienced during the war, and prices rose phenomenally. Schemes were prepared for increasing the output, but with the whole of the smelting capacity of the United Kingdom in operation only 80,000 to 85,000 tons could now be produced annually.

During 1919 the world's production amounted to about 520,000 tons, including 410,000 tons in the United States, but only about 20,000 tons in Great Britain, where the output has been limited by shortage of ore and by labour troubles. Belgium only recommended smelting towards the middle of the year, and was hindered by shortage of ore and the difficulty of securing sufficient shipping tonnage even at high prices. During 1919 British imports of spelter amounted to 94,226 tons.

At the present time production is progressing satisfactorily in America, but Belgium is producing only 6500 tons a month, or 39 per cent of the pre-war output, and Germany 3500 tons, or 14 per cent, and Great Britain 2000 tons, or 40 per cent. It is obvious that until conditions improve we are dependent on American supplies. Owing to the necessity of preference being given to the shipment of foodstuffs, wool, and other essential commodities, zinc ore is being shut out, and there seems no prospect of the British or Belgian works being able to run their furnaces at full capacity during the coming months; but even then the output in the United Kingdom will be limited by the amount of plant available. If we are to become independent of foreign supplies of spelter the extension of existing plants and the erection of new works are necessary.

During the war zinc smelting was classified as one of the important key industries, but no steps have yet been taken to make the country self-supporting, although ample supplies of ore are available within the Empire.

For the ten years before the war the average price of g.o.b. spelter in London was £23 16s. 5d. Since then the average prices have been :—

| | | | |
|---|---|---|---|
| 1914 .. .. .. .. .. .. | £23 | 6 | 8 |
| 1915 .. .. .. .. .. .. | 66 | 13 | 8 |
| 1916 .. .. .. .. .. .. | 68 | 18 | 11 |
| 1917 .. .. .. .. .. .. | 52 | 3 | 6 |
| 1918 .. .. .. .. .. .. | 52 | 4 | 0 |
| 1919 .. .. .. .. .. .. | 42 | 5 | 3 |

On the technical side important improvements have been made in recent years. Ordinary wet methods for the concentration of zinc ore have been superseded by the flotation process, electro-magnetic separation being now used only quite exceptionally. Flotation has necessitated finer crushing, but it has been found that higher recoveries are obtained, while the grade of the concentrate is improved owing to more complete elimination of the gangue.

In the treatment of zinc concentrates no radically new methods have yet proved suitable. Electrolytic precipitation has been tried in a number of works in the country, but all of these have been shut down, including the Hoepfner process plant at Winnington, from which such a good product was obtained for several years. It is interesting to note that at the same time electrolysis has been adopted for the new plants in Tasmania, Canada, and at one works in the United States, but in each of these cheap power is available. The demand for high-grade zinc will be large in future, but it can now be obtained cheaply by new means which were worked out during the war. Much progress has been made with the electric furnace reduction in Norway, Sweden, and France, and the troubles experienced in the condensation of the zinc vapour have been largely overcome, but here also cheap power is essential.

Hand-rabbled furnaces for roasting are rapidly being replaced by mechanical furnaces, and these are already satisfactorily in operation in several works in the country. The saving in labour is important, and at the same time a more regular product is obtained and the consumption of coal decreased. The even supply of sulphur fumes materially facilitates the working of sulphuric acid plant, and avoids the losses of nitre which take place when hand furnaces have to be worked intermittently.

Pot-making machinery was in the past obtained from Germany, but during the war complete plant for this

Purpose was designed and manufactured here, and has given entire satisfaction. Novel apparatus for more efficiently mixing the different clays has proved successful. Clay for pot-making used to be imported from Belgium, Germany, and Austria, but the war stimulated experiments with British clays, and these can be used as well as the imported materials, giving a good pot life when working at a high temperature. After drying and burning the red-hot pots have to be taken to the furnace and put into place. Even in this arduous operation hand labour is replaced by a simple semi-automatic apparatus, and a good deal of delay to the furnace is being saved by this means.

The results obtained with improvements in the design and construction of the zinc distilling furnaces are worth recording. To reduce 10 tons of ore 14½ to 15 tons of coal was formerly required for heating. In a plant built during the war the coal consumption has been reduced to under 8 tons, a figure which constitutes a world's record. The furnaces are built with counter-current recuperators, and there are no reversing valves requiring attention; the heat in the waste gases is so efficiently utilised to preheat the air that the temperature of the gas going to the chimney stack is reduced very much below what was formerly considered possible.

Weighing, mixing, and transportation of the charge to the furnaces is now done entirely mechanically, so that much labour is saved and supervision facilitated.

Charging the pots in the furnace probably used to be the most laborious work of the zinc smelter, and this has been overcome with the aid of charging machines. These are driven electrically, and are much more efficient than hand charging, the pots being more uniformly charged and the charge denser. The duration of the manœuvre is shortened by about two hours, and the time for working off the charge is increased correspondingly, because 14 tons of charge can be fed into the pots in less than twenty minutes.

The more extensive use of machinery reduces the number of men, and at the same time makes the management more independent of skilled workmen.

The outlook for the zinc industry in Great Britain is not promising unless the existing works can be brought up to date and the smelting capacity increased by the construction of additional works. New plant built during the war has demonstrated that zinc smelting can be carried on efficiently, economically, and profitably provided that the best designs and apparatus are adopted, and in view of the large demand for metal in the Empire it is to be hoped that means will be found so that it will become unnecessary to rely upon imports from foreign countries.—*Journal of the Society of Chemical Industry*, Jan. 15, 1920.

## THE ESTIMATION OF ORGANIC CHLORINE OR BROMINE BY THE CHROMIC ACID METHOD.

By P. W. ROBERTSON.

SINCE the publication of the paper on this method (Robertson, *Trans. Chem. Soc.*, 1915, cvii., 902) a number of communications have been received testifying to its general applicability, but at the same time certain minor difficulties have been pointed out. It is the object of this note to indicate how these may be avoided.

The method is to heat the organic substance with chromic anhydride and concentrated sulphuric acid in a simple apparatus, absorb the volatile halogen compounds thus produced in a solution of sodium hydroxide containing a little hydrogen peroxide, and then titrate with decinormal silver nitrate. The chromic anhydride may be replaced by potassium dichromate, which should, however, be tested for traces of chloride and recrystallised if necessary. As absorbing medium alkaline perhydrol solution was formerly recommended, as ordinary hydrogen peroxide usually contains a little chloride. It has been found convenient to replace this by a cold freshly pre pared solution of sodium peroxide (which is almost invar ably chlorine free). Finally N/20 solutions of silve nitrate and ammonium thiocyanate are recommended i place of N/10 solutions.

The chief difficulty encountered has been that certai compounds, chiefly liquids, are apt to react explosivel with the oxidising mixture, even if it has been previousl cooled. In such cases it is advisable to proceed as follows The substance is covered with rather a large amount o powdered potassium dichromate, and the sulphuric acid previously cooled, is made to run into the reaction vesse very *rapidly* (through as wide a funnel as possible) b means of a suction-pump connected with the absorptio tube. The reaction vessel is then cooled in ice until th initial violence of the oxidation has sufficiently moderated With these precautions satisfactory results may b obtained even for extremely reactive compounds.

## THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ

(Continued from p. 45).

22. *The Character of the Oxide Formed when an Aqueous Solution of Uranyl Acetate is Electrolysed.*

IN the early work on the quantitative determination c uranium electrolytically Smith (*Am. Chem. Journ.*, 1879 i., 329) determined the composition of the dark deposit t be $U_3O_4H_2O$. His results are calculated by using th atomic weight of uranium as 120. If his analyses ar calculated using the present atomic weight (238·5) th composition of the deposit becomes $U_3O_8.2H_2O$.

Several grms. of the black residue were prepare according to Smith's directions and subjected to carefu analysis, and the results obtained would indicate that th product is not the hydrated green oxide as given. Th difference is easily explained on the basis of the analysi made.

The residue left after the determination of the wate content was taken to be the green oxide of uranium an calculated accordingly. All analyses made have show that when the water is driven off by passing a current o air or oxygen over the residue heated in a combustio tube, the residue left is richer in oxygen than the com pound $U_3O_8$.

Results of analyses are given in Table VI. I samples 1 and 2 the uranium content was found by dis solving the material in nitric acid and precipitating th uranium with ammonium hydroxide.

The empirical formula as calculated from the result obtained becomes $U_3O_{10}.2H_2O$. Smith explained the dis crepancy between the weight of his residue and the weigh of water found as due to loss of oxygen, but it is highl probable that the product which he weighed as $U_3O_8$ wa still richer in oxygen than $U_3O_8$ should be.

23. *A New Method for Measuring the Single Potential c Metals and Oxides in Powder Form.*

The single potentials of metals against their salt solu tions are usually measured by using either cast pieces c metal, where this is possible, or an electrode prepared b plating the metal in question on another metal. In cas the metal cannot be plated or cast, the determination o the single potential is difficult.

The measurement can be made on metals and oxides i powder form by pasting the finely powdered metal o platinum, or any other good conducting metal wit gelatin. In the experiments tabulated below the electrode

* From the *Journal of Physical Chemistry*, xxiii., No. 8.

prepared by first moistening a platinum electrode a solution of gelatin and then spreading the finely ed metals or oxides over the platinum and pressing firmly with a spatula. Each measurement was compared with results obtained by other investigators using trolytes of the same strength as have been used in investigation. The results are given in Table VII.

TABLE VI.

| ple. | Weight. Grms. | Weight of water. Grm. | Weight of residue. | Weight. $U_3O_8$. | P c. $H_2O$. | P c. U. |
|---|---|---|---|---|---|---|
| | 0·2998 | — | — | 0·2783 | — | 78·74 |
| | 0·3021 | — | — | 0·2800 | — | 78·62 |
| | 1·0318 | 0·0385 | 0·9650 | 0·9578 | 3·73 | 78·73 |
| | 1·0258 | 0·0403 | — | — | 3·92 | — |
| | 0·5905 | 0·0209 | 0·5511 | 0·5490 | 3·54 | 78·86 |

he zinc used was Baker's "C. P." zinc dust. The per was precipitated electrolytically from a copper hate solution by metallic zinc and the excess zinc oved by digesting with dilute sulphuric acid. The er was prepared by reduction of the pure oxide in rogen. The gelatin was the commercial product lled "Gold edge." The solution was prepared by olving 0·5 grm. in 25 cc. of water and applied while liquid.

he measurements made with metals show that the hod is reliable.

he manganese dioxide was Merck's "C. P." product the lead peroxide, Mallinckrodt's preparation, labelled P.". The potentials obtained by plating manganese xide give higher value than the pasted material. This no doubt due to a different state of hydration. An ctrode, when prepared by plating, always gave lower dings after it had dried in the air. The moist, pasted trode gave higher readings when left exposed to the This was also true of the lead peroxide when pasted, the potentials found are of the same order of magnitude and possess the same polarity. The potential asurements for manganese dioxide as made by Tower *rit. Phys. Chem.*, 1900, xxxii., 566) were obtained immediately upon removal from the plating bath.

24. *The Single Potential of Uranium and its Oxides.*

With the exception of the green oxide of uranium, the ides are difficult to prepare in absolutely pure form. The drated oxide $UO_3H_2O$ is first deposited when an aqueous lution of any uranyl salt is electrolysed, but the product obtained is usually contaminated with a black oxide pecially when the uranium is almost depleted. Uranous ide $UO_2$ can be obtained in a fair state of purity by reducing ammonium uranate in a current of pure dry drogen. This, however, is pyrophoric and absorbs ygen from the air, becoming $U_3O_8$. This is especially ie when prepared from the uranyl salts of organic acids ch as the oxalate and acetate.

Anhydrous $UO_3$ has been prepared by heating uranyl trate to 250° for several hours (Jacquelain, *Chem. harm. Centralblatt*, 1845, 193). However, the purity of e product is questionable unless the work is done in an mosphere of oxygen, since the green oxide $U_3O_8$ tends form.

Other oxides have been described in the literature, but eir existence as definite compounds is more or less estionable.

The green oxide $U_3O_8$, being the high temperature ide, is most easily prepared by igniting ammonium anate in the air to constant weight. The pure oxide was epared in this way and used for the potential measurements herein recorded. The finely ground powder was asted on a platinum electrode with gelatin and the single otential was then measured against a solution of uranyl itrate which contained 14·3 grms. of anhydrous uranyl itrate per litre. The half element was the usual form of normal mercury calomel electrode. The results are iven in volts and are fairly constant for the different lectrodes prepared from different samples of the oxide.

TABLE VIII.

| Sample. | Observed potential. |
|---|---|
| 1 | −0·778 volt |
| 2 | −0·787 volt |
| 3 | −0·779 volt |
| 4 | −0·785 volt |

A sample of pure uranium oxide $U_3O_8$ obtained from Dr. S. C. Lind, of the Bureau of Mines, Boulder, Colorado, when pasted on platinum with gelatin, gave a single potential of −0·773 volt.

A sample of uranous oxide $UO_2$ prepared by heating ammonium uranate in a current of hydrogen was used for measuring the potential. It gave on analysis 87·65 per cent uranium. By calculation pure $UO_2$ contains 88·17 per cent uranium.

The potential of this material gave a value for three different electrodes prepared with gelatin.

−0·778 volt
−0·773 volt
−0·776 volt

With $UO_2$ the value is the same as that found for $U_3O_8$. It is possible that there is a superficial oxidising effect which causes the result to be the same.

The hydrated yellow oxide was prepared by electrolysis of a neutral solution of uranyl acetate. It was deposited in small quantities with a voltage of 6 and a current density of 0·108 amp. at room temperature. The first deposit formed is entirely yellow, but if allowed to remain until considerable free acetic acid is present, the yellow compound is contaminated with the lower black oxide. As soon as the cathode showed a slight blackening the electrolysis was interrupted and the solution filtered from the yellow deposit. By proceeding in this way with other portions of fresh uranyl acetate, enough yellow hydrated oxide of a high grade of purity was obtained for analysis and for potential measurements. Ammonium hydroxide or fixed alkali hydroxide added during electrolysis of an acetate solution reduces the acidity and prevents the formation of the black deposit, but the product obtained in this way is the alkali uranate and not the yellow oxide.

Analysis of the product showed—

U 76·53 per cent, water 7·36 per cent, oxygen by difference 16·11 per cent. The formula of the product thus becomes $UO_3H_2O$.

The single potential of the product measured against the standard solution of uranyl nitrate gave a constant value of −0·860 volt. The value given was obtained on four different electrodes prepared by pasting the oxide on platinum with gelatin.

The black deposit formed when an aqueous solution of a uranyl salt is electrolysed when pasted on platinum with gelatin gives a single potential of −0·6872 volt. This is conclusive evidence that the deposit is not $U_3O_8$ as formerly supposed, and both the potential and the analysis support this conclusion.

A sample of metallic uranium prepared by Schuchardt was analysed and found to contain uranium 91·49 per cent, ferric oxide 8·34 per cent.

It was used for making a single potential measurement by pasting the finely powdered material upon platinum with gelatin. The maximum potential obtained in this way was −0·093 volt for the sample. The potential decreases rapidly in contact with the uranyl nitrate solution which indicates a rapid oxidation of the metal.

25. *The Single Potential of the Black Oxide Plated on Platinum.*

By using an electrode covered with platinum black a smooth, adherent deposit of the black oxide can be obtained. Single potentials of this measured against the standard uranyl nitrate solution gave variable results depending upon the treatment given the deposit. The first deposit obtained with a pressure of 13·5 volts and a current density of 3·11 amp. gave the same potential

formerly obtained from aqueous uranyl salt solutions, namely, −0·497 volt. With this sample, the small amount of the yellow oxide present was washed off with dilute acetic acid.

The electrode was used for obtaining a heavier deposit, and under similar treatment gave for the second reading a maximum of −0·361 volt. The value diminished rapidly.

Electrolysed again for one hour with all factors identical the maximum potential reading was −0·302 volt.

When the electrolysis was allowed to continue until the uranium was depleted, the value for the potential was much greater. If the potential is measured immediately upon removal from the electrolytic bath higher values will be found. Voltages as high as −0·4999 volt have actually been measured. This product when allowed to stand in contact with the standard uranyl nitrate solution or in the air gives decreasing values. The voltages fall off gradually and change polarity due to slow oxidation of the deposit. When washed with dilute acetic acid before taking the potential, the initial value was repeatedly found to be about ± O potential, but here the value was dependent upon the time which elapsed between the removal from the electrolytic bath and the measurement of the potential.

These variable results are no doubt due to occluded hydrogen in the deposit. However, experiments showed that this deposit does not serve as a hydrogen electrode in the same manner as platinum black does. No constant value for hydrogen was obtained, and the potential readings decreased in the usual manner when the deposit was used as a hydrogen electrode. No constant values could be obtained upon which to base a conclusion.

26. *Reaction of Uranium Tetrachloride with Paraffin.*

An attempt to prepare metallic uranium by allowing uranium tetrachloride to react with metallic sodium under molten paraffin was not successful. Instead of reacting with the sodium the uranium tetrachloride reacts with the paraffin, evolving hydrochloric acid. The exact nature of the reaction is as yet unknown. When the excess paraffin is removed by petroleum ether and washed free from all chlorides present there is left a brownish black material insoluble in ice water. The product gives a potential exactly the same value as $U_3O_8$. In this respect it behaves like $UO_2$ produced by reduction in hydrogen. From its polarity and potential it is probably an oxide of uranium rather than metallic uranium.

The analysis of the substance dried to constant weight over sulphuric acid gave 52·67 per cent metallic uranium and 46·54 per cent carbon. A portion of the carbon was probably oxidised by the nitric acid used to separate the uranium from the mixture. Further examination of the reaction of uranium tetrachloride with organic material will be made.

(To be continued).

## PROSPECTS OF CEREAL SUPPLY IN 1920.

The December *Bulletin* of Agricultural and Commercial Statistics, just published by the International Institute of Agriculture of Rome, includes features of very considerable interest as regards prospective supplies of cereals for 1920. During the last six weeks, as shown in the Statistical Bulletins, a further dislocation in the rates of exchange has added about 10 per cent to the cost of importing cereals from North and South America for the principal European countries; the neutral powers, Spain, Netherlands, Scandinavia, and Switzerland, are exempt as their exchange has not suffered.

So far as available the details of each of the cereal crops, wheat, rye, barley, oats, and maize, in the Northern Hemisphere have been published in previous Bulletins of the International Institute, and the present number confirms these returns, with one or two supplementary data for Denmark, Moravia, &c.

The rice crop of Spain, Italy, United States, Guatemala Dutch East Indies, Japan, Corea, and Formosa forms a aggregate of 217 million quintals, as compared with 20 millions in 1918. The available figures of 1913-17 cannc be brought into comparison, as they do not refer t precisely the same countries. The estimates must remai quite incomplete until those of British India come to hand where the prospects are reported as good.

The outlook of the cereal crops for the coming seaso is generally propitious, so far as concerns autumn prepara tions in Denmark, France, England, Italy, Canada Japan, and Egypt, though in Scotland, Ireland, an Slovakia conditions were less favourable in November.

A statement of the available exportable surplus c wheat in the United States shows that on November 8 1919, the remaining quantity was 73 million quintals, a compared with 60 million quintals on November 8, 1918 in each case allowing for the normal stock of old whea at harvest time in 1920 and in 1919 respectively. Th total quantity exported, as wheat and flour, from th United States during the previous season from August 1 1917, to July 31, 1918, was 36 million quintals.

Stocks of rye in elevators in the United States also in dicate an increase from under a million quintals a November 29, 1917, to four million quintals at the sam date in 1919.

The production of beet sugar in Belgium, Denmark and the Netherlands indicates a satisfactory increas during the coming season.

An interesting return just telegraphed from Canad shows that the numbers of live stock in that country ar fully maintained.

Rome, December 22, 1919.

## BOARD OF TRADE ANNOUNCEMENTS.

### Clearing Office (Enemy Debts).

The Controller desires to notify the public that the pre war rate of exchange on Germany referred to in the Treat of Peace at which debts or claims against Germa nationals are convertible into British currency is—Mark 20.5075 equals £1, and that the calculation must be mad by the creditor or debtor before preferring his claim c tendering payment of his debt. Notice is also given t debtors of German nationals for sums of under £50, wh were not required under the Proclamation to register the debts with the Public Trustee, that they are required a once to pay to the Controller at Cornwall House, Stamfor Street, S.E. 1, the amount of such debts with interest a 5 per cent per annum from August 4, 1914, except in case where the debtor is liable to pay interest at some differe rate or from some other date. Creditors in preferrin their claims are earnestly requested to comply with th directions in the margin of the form of proof and circula letter which was sent to them by the Controller. It is i importance that two extra copies of the detailed particula of the account which is endorsed on or exhibited to th proof should be attached to it when lodged at the Clearin Office. Failure to observe this requirement will lead t delay in payment of the claim.

### British Dye Purchases in Germany.

With reference to the paragraphs which appeared in number of newspapers on January 22 relative to Britis Dye Purchases in Germany, the Board of Trade announc that there are some important inaccuracies in the state ments made. The Committee mentioned in the para graphs in question was selected by the colour using trade and is acting on their behalf and not on behalf of th Board of Trade, and the British Government is no responsible for the finance of the purchases. The actio taken is however with the full knowledge and approval c the Board of Trade. It may be added that the quantit

lyes to which British users are entitled under the re- ation clauses of the Peace Treaty will probably be sub- ntially in excess of the 1500 tons stated, but the pur- se now being made will be in addition to whatever ount may be received under the Peace Treaty.

## PROCEEDINGS OF SOCIETIES.

### THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

MEETING was recently held at the offices of the sociation of British Chemical Manufacturers, 166, cadilly, London, W. 1, at which Mr. W. J. U. OOLCOCK, M.P., occupied the chair, for the purpose of cussing with Sir Robert Blair, the Chief Education icer of the London County Council, a scheme for mpulsory Day Continuation Schools under the Educa- n Act, 1919.

The CHAIRMAN introduced Sir Robert Blair and explained reason of his visit.

Sir ROBERT BLAIR then addressed the meeting, and ceeded to expound the conditions under which the ucation Department of the London County Council emed it advisable for the contemplated action to be ten. Hitherto boys and girls having left the Elementary hool were free to do as they wished. Some 20 per cent ould attend evening schools, whilst 80 per cent would do thing with their time, and probably drift into blind-alley os. Compulsory education, therefore, appears to be sential if boys and girls are to follow useful occupations. e Act requires that after a given day boys and girls who ive at fourteen years of age shall attend Compulsory ay Continuation Schools for eight hours a week for forty eks in the year. The compulsion applies to boys and rls who reach the age of fourteen after the appointed y, which will probably be some time next autumn, and t to any who were fourteen on or prior to that day. The ligation is to apply at first only to boys and girls between urteen and sixteen, and seven years from the appointed y will apply to those between sixteen and eighteen. In ew of the fact that boye and girls may live in one strict and work in another, the problem of arranging the ours for attendance at these schools is very difficult; but r Robert Blair finally suggested that two days of four ours each, either morning or afternoon, would be the best lution. The opinion of those present was that this ethod should be adopted. There is also an obligation on e part of the employer to allow sufficient time for the oy or girl to reach the school and to be in a fit physical ondition to assimilate their lessons. As regards the hemical industry, Sir Robert Blair suggested it might be dvisable to establish a chemical school where the pupils ould not only take general education but also receive uition in chemistry. It is therefore necessary to ascertain e number of boys and girls of the suitable age engaged in e chemical industry in London, and he asked the meeting o endeavour to supply this information. If such pupils eside in the London area the obligation rests on the London County Council; if they reside outside this area nd work in London, the obligation rests on the authority n whose area the pupil resides. The question of estab- shing special schools for boys and girls engaged in any articular industry will therefore need careful considera- ion.

Sir ROBERT put a question as to whether the chemical ndustry was seasonal, wholly or partly, and the meeting ave the following information:—

Tar distillers, pharmaceutical and fine chemical branch—
No season; busy all year round.

Gas companies.—Seasonal; winter the heaviest time.

Fertilisers.—Seasonal. Autumn, winter, spring busy; summer slack.

It appears there are 60,000 children leaving the London elementary schools yearly. Provision will have to be made in these Compulsory Continuation Schools for 240,000 pupils when the Act comes into force. The problem of accommodation and the provision of teachers will there- fore give considerable trouble to the responsible authorities.

The next question was that of the curriculum. In many schools this will be of a general character, but where pupils are engaged in specialised trades instruction in the techni calities of such trade will be introduced.

Sir ROBERT then suggested that where a firm had a sufficient number of boys and girls of the proper age on their staff the question of providing a schoolroom on their premises should be considered, and if the firm also had on their staff adults capable of giving the requisite teaching this would obviate the necessity of boys and girls attending separate Compulsory Continuation Day Schools. He also stated that the "appointed day" would probably be July 31 or October 31, as already indicated in the Act. Boys and girls would not, therefore, leave on the day they attained the age of fourteen, but at the end of the term in which they reached that age. This will mean that approximately 15,000 will leave the elementary schools at the end of each term. He further stated that it was most important to consider whether these boys and girls should be exempt from Continuation Schools by attending full time schools. In response to various questions, Sir Robert said that Secondary and Central Schools would be most suitable for full time education. Employers appear to have the right to refuse to employ children under the age of sixteen. A private works school would be recognised by the authorities provided the curriculum and the number of pupils satisfied the local education authority. It was hoped that the appointed day would be the same for Greater London and for other local authorities.

The CHAIRMAN referred to the question of the number of boys and girls employed in chemical factories in the London area, and the opinion of those present was that approximately 15 per cent of the total number of employees would be boys and girls between fourteen and eighteen years of age, based on the Home Office figures of 20,000. It was therefore estimated that provision would have to be made for 3000 pupils engaged in the chemical industry in the London area. So far as gas companies are concerned, it was stated that the percentage was about 10 to 12 per cent.

Referring to the question of the curriculum, Sir ROBERT BLAIR made the following statement:—"In the first two years physical education must be taken; one of the special provisions under the Act is that physical education is necessary. Then for general subjects there would be writing, English, some English literature, history, and geography. That would be for boys from fourteen to sixteen, then later for boys sixteen to eighteen more technical subjects would be taken—mathematics, science—and for boys going into different trades a subject fitting to those trades, such as rates of exchange for insurance and banking, and accounts for commercial offices, and so on."

### MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

(CHEMICAL SECTION).

*December 18, 1919.*

Mr. H. N. MORRIS in the Chair.

"*Future Supplies of Motor Fuel.*" By HAROLD MOORE.

The author dealt with the supply of motor fuel, and the possibility of meeting future demands by increased pro- duction of petroleum spirit. He dealt with benzol as a motor fuel, and also with alcohol. He suggested alcohol as the most promising source of petrol substitute at the present moment, and indicated alcoholic fermentation of

vegetable matter for its supply. He urged the advantages of mixed motor fuels, with especial reference to the compression pressures of engines and to the vapour tension of mixed fuels.

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MINERALOGICAL SOCIETY.

*January* 20, 1920.

Dr. A. E. H. TUTTON, F.R.S., Past-President, in the Chair.

"*Gearksutite at Gingin, Western Australia,*" By Dr. E. S. SIMPSON.

The mineral, which occurs in cretaceous greensand, is considered to have a composition corresponding to the formula $CaF_2.AlF(OH)_2.H_2O$, and to have originated from the interaction *in situ* of fluorapatite, gibbsite, and carbonated water.

"*Fibroferrite from Cyprus.*" By C. E. BARRS.

Analysis of material from Skouriotissa, Cyprus, gave the following result:—$Fe_2O_3$, 31·36; $SO_3$, 30·95; $H_2O$ (by difference), 37·01; insoluble, 0 68.

"*On the Classification of Meteorites.*" By Dr. G. T. PRIOR.

For purposes of the classification of meteorites the significance is pointed out of the chemical composition of the nickel-iron and the magnesium silicates. In the case of meteoric-irons the structural features, as revealed by etching, are shown to be closely related to the content of nickel. In meteoric stones the proportion of magnesia to ferrous oxide in the magnesium silicates varies directly with the proportion of iron to nickel in the nickel-iron. On these principles the four classes of meteorites, viz., irons, stony-irons, chondrites, and achondrites, can be divided into inter-related groups. The three groups of chondrites are distinguished as enstatite-chondrites, bronzite-chondrites, and hypersthene-chrondrites according to the chemical composition of the pyroxene. The achondrites are divided into corresponding groups of enstatite-achondrites, bronzite (-augite) -achondrites, and hypersthene achondrites, while a fourth group is added richer in lime (and mostly also in alumina) than the chondrites. To avoid confusion owing to Brezina's misuse of the term chladnite, the enstatite-achondrites, comprising Aubres, Bustee, and Bishopville, are called aubrites, while for the hypersthene-achondrites (Shalka, &c.) a reversion is made to Tschermak's original name of diogenite.

"*On Torbernite.*" By A. F. HALLIMOND.

In continuation of the author's previous work a series of weighings were made on Gunnislake material held over various concentrations of sulphuric acid. Dehydration did not occur at the pressure required, and only took place slowly over strong acid in a period of many months. It is clear that this mineral cannot be identical with ordinary torbernite. The refractive index agrees with that found for an abnormal torbernite by N. L. Bowen. Normal torbernite has the density 3·22 and mean index 1·585, while for artificial metatorbernite and for the Gunnislake material the density is 3 68 and the index 1·624. An approximate reading yielded for Gunnislake crystals $c:a = 2·28:1$. The basal planes of the two forms are of the same dimension, and the volume change due to the addition of $4H_2O$ is borne by an increase in the vertical axis. The density of the water of crystallisation is 1·2, a value common in hydrated salts, while the refractive power is equal to that for liquid water.

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INDIAN MARKET FOR DRUGS AND CHEMICALS.—There is a big demand for drugs and chemicals in India as the supply is uncertain and short owing to the delay in shipments. If this can be remedied the market will welcome supplies even at enhanced prices.—*Reuter's Trade Service*.

## NOTICES OF BOOKS

*Applied Chemistry* (Vol. I.). By C. KENNETH TINKLE D.Sc., F.I.C., and HELEN MASTERS, B Sc. P xiii+292. London: Crosby Lockwood and Son, Stationers' Hall Court, E.C. 1920. Price 12s. 6d. ne

THE authors of this book are lecturers in Household ar Social Science at King's College for Women, Dr. Tinkl being head of that department.

They have written the book in an endeavour to supp a text-book for third year students studying for the Unive sity Diploma in the Household and Social Science Depar ment. It represents the first volume and contains chapter on the analysis of water, and methods now i use for softening water; followed by one on soap wherei is explained its preparation, reactions, and chemic examination.

Textile fibres are next dealt with. This chapter spread over 46 pages, and the commoner fabrics are ful explained, helped by two plates of photomicrograph Following on this chapter is one dealing with chemic reagents which are used for the removal of colourin matters from textiles, in other words bleaching agent This chapter is divided into two sections—(a) tho reagents which "bleach" by an oxidation process and ( those which are effected by reduction.

Except for the last chapter, the remainder of the boc is given up to gas analysis, commencing with the analys of air in regard to its impurities, such as carbon dioxid sulphur dioxide, &c. Coal-gas analysis is next dealt wit together with a method for the determination of i calorific value.

The last chapter, entitled "Materials used for the pr tection of wood, metal, and other surfaces," gives a br *résumé* of the analysis of paints, metal-polishes, ar glazes for pottery ware.

The book is written in a simple style and should l easily understood by those who have not had a course pure chemistry.

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## NOTES.

ON and after January 31, 1920, the address of the I stitution of Petroleum Technologists will be 5, John Stree Adelphi, W.C. 2.

MR. A. C. J. CHARLIER, President of the Nation Association of Industrial Chemists, has been re-electe President of the Federation of Technical and Scientif Associations.

THE Board of Trade announce that the Scientific I struments, Glassware, and Potash Production Branc and the Mineral Resources Development Department ha now removed from 7, Seamore Place, Curson Stree W. 1, to the New Public Offices, Great George Stree S.W. 1. (Telephone No. — Victoria 9800). The Office the Controller of Trading Accounts has also removed Great George Street from Gwydyr House Annexe, Whit hall, S.W. 1.

POSTAGE OF PRINTED MATTER OVERSEAS.—H.M Consul-General at Antwerp, while gratified at the respon made by British firms to his recent appeal for catalogu and samples, is astonished that about 30 per cent of t letters and packages received in this connection we understamped—no less than 38 francs having be expended on taxed letters during two days alone. It is matter of some surprise that business men do not reali the importance of ensuring the correct stamping of the foreign mail, this being a matter that should not, be co sidered, be left to a junior office boy. The numero taxed understamped letters received by Consular Office emanate for the most part from commercial houses, a not from private individuals or the professional classes.

itute of Chemistry.—*Pass List: January* (1920) *nations.*—The results of the Examinations of the te of Chemistry recently held in London have now oblished. For the Fellowship:—In the Branch of urgical Chemistry—G. B. Brook; in the Branch of emistry of Food and Drugs, Fertilisers, and Feeding Soils, and Water—F. F. Beach, M.A. (Oxon), (Lond.). For the Associateship:—In the Branch ganic Chemistry—H. H. Barber, B.Sc. (Lond.), McHatton, A.R.C.S., and H. C. S. de Whalley; in anch of the Chemistry of Food and Drugs, Fertilisers, eeding Stuffs, Soils, and Water—John Haycock and E. E. Sparling.

'aper entitled "The Theory and Practice of Lubri- —the Germ Process" is to be read by Henry M. and James E. Southcombe, M.Sc., at a meeting of ondon Section of the Society of Chemical Industry rlington House, Piccadilly, on February 2 next at .

e Secretary of the Department of Scientific and In- ial Research begs to announce that the Research iation for the British Launderers' Industry has been oved by the Department as complying for the con- is laid down in the Government scheme for the en- gement of industrial research. As the Association be registered as a non-profit sharing company, the oters have applied to the Board of Trade for the of a licence under Section 20 of the Companies' solidation) Act of 1908. The Secretary of the Com- e engaged in the establishment of this Association is Stark, Esq., 162-5, Bank Chambers, 329, High orn, W.C. 2.

ie Clearing Office for enemy debts provided for in the ty of Peace with Germany has now been established, Mr. Egerton Spenser Grey, Senior Official Receiver ankruptcy, has been appointed Controller. All com- ications should be addressed to the Controller of the ring Office, Cornwall House, Stamford Street, S.E. 1. se premises provide the only adequate accommodation lable for the offices of the Clearing Office. At the est of the President of the Board of Trade the fol- ng gentlemen, who have consented to serve in an orary capacity, will act as a Committee to advise the troller in the operation of the Clearing Office:—Sir liam Plender, C.B.E. (Chairman), Mr. George Watson, O. R. A. Simpkin, C.B.E. (Public Trustee), and Mr. A. Payne, C.B. (Board of Trade). Particular branches ndustry and commerce are being invited to nominate resentatives to confer with the Controller on technical stions. Notices giving instructions as to the steps to taken for proving their claims have been sent to ditors in the United Kingdom who have registered with Public Trustee as Custodian claims against German ionals. Notices requesting payment of their debts to Controller have also been sent to debtors in the United igdom who have registered with the Public Trustees as stodian debts owing to German nationals. Any ditor or debtor who does not receive a notice should nmunicate with the Controller of the Clearing Office.

ndustrial Problems.—What should prove an in- uctive as well as interesting series of lectures dealing h Industrial Problems are those which have been ar- nged to take place at the Carpenters' Hall, Throgmorton enoe, under the auspices of the Industrial League and uncil, which has its headquarters at 82, Victoria Street, W. 1. Sir George Paish, financial expert, whose esent visit to America has aroused such widespread erest, has promised to give a lecture almost as soon as returns from that country, and the subject of his address ll be "A Defence of Capitalism." Anyone desiring to tend the lectures can obtain full particulars with tickets m the Secretary to the League and Council. "The dustrial Situation" is the title of an address which is to given by the Right Hon. W. Adamson, M.P. Mr. J. Wardle, C.H., M.P., Parliamentary Secretary to the Minister of Labour, is due to give an address on "Indus- trial Unrest and Whitley Councils," and a lecture to be given by Mr. T. E. Naylor will deal with "Trade Unionism and Output."

New Journal.—Mr. Murray announces the publication of a new monthly journal, entitled *Discovery*, that has for its aim a popular description of the advance made in the chief subjects in which investigations are being actively pursued. The journal will also give from time to time some account of new ideas in more abstract subjects, like Social Science or Mathematics, and in the organisation of knowledge, where, though definite and concrete "dis- coveries" are rare, new methods and new points of view may be interesting and important to every one. The articles, singly or in a series, will deal with their subjects in such a way as to make clear the interesting features in the discoveries with which they deal, and will be written in plain, simple language by contributors who can speak with authority in their own branch of knowledge, so that the teacher or general reader who has no time to pursue specialised study—or, if he has, can do so in only one subject—will be able to obtain at first hand an account which he can understand of all the chief things which experts are doing or have done in all the chief branches of know- ledge. In each article there will be given the names of books or periodicals in which the subject of the article may be studied more fully. At the present time there is no one journal which fulfils this purpose, and it is to meet this want that *Discovery* has been established. Each number is expected to provide about 24 pages of reading matter. *Discovery* will be published for the Trustees by Mr. John Murray, 50a, Albemarle Street, London, W. 1, and be edited by Dr. A. S. Russell, 8, Severn Road, Sheffield. It is maintained under a deed of Trust, the first Trustees being Sir J. J. Thomson, O.M., P.R.S., Sir F. G. Kenyon, K.C.B., P.B.A., Prof. A. C. Seward, Sc.D., F.R.S., and Prof. R. S. Conway, Litt.D. F.B.A. It is announced that in the Chemistry and Physics Section papers will appear on the Radio Elements, Transmutation, Glass, Stainless Steel, Crystal Structure, &c.

The following awards have been made by the Council of the Institution of Mining and Metallurgy:—(1) Gold Medal of the Institution (premier award) to Mr. H. Livingstone Sulman, M.Inst.M.M., in recognition of his contributions to Metallurgical Science with special refer- ence to his work in the development of Flotation and its application to the recovery of minerals. (2) "The Con- solidated Gold Fields of South Africa, Ltd.," Gold Medal to Mr. William Henry Goodchild, M.Inst.M.M., for his papers on "The Economic Geology of the Insizwa Range" and "The Genesis of Igneous Ore Deposits." (3) "The Consolidated Gold Fields of South Africa, Ltd.," Premium of Forty Guineas to Dr. Edward Thomas Mellor, M.Inst.M.M., for his paper on "The Conglomerates of the Witwatersrand."

Scientific Management.—Much has been said, much has been printed, and infinitely more has been thought in the course of the last few months on the subject of Scientific Management. Yet, withall, one is consistently met with the interrogation: What is Scientific Management? On the face of things it would appear that Scientific Manage- ment is the offspring of what is becoming now a back- neyed phrase, "Increased Production," but is it? That the two things are in a measure synonymous is apparent. While one is a natural sequence the other is an essential element; since to obtain increased production it is funda- mentally necessary to install some system of scientific management. To fight for increased production without adjusting the managerial side automatically brings about the same thing, though the process is rather long and wearisome. It is with a view to educating the public, particularly those people engaged in any branch of com- mercial activity, that the Industrial League and Council, which has its headquarters at 82, Victoria Street, S.W. 1, has organised a series of lectures to be given in the Con-

ference Hall of the Central Hall, Westminster. Among the speakers, together with their subjects, who are due to give lectures are Mr. J. F. Butterworth, "Modern Methods in Industry"; Major E. A. Pells, "Conditions the Workers may Control"; Mr. W. J. Grosart, "Evolution of Modern Methods in Industry"; Mr. H. Atkinson, "Economical Production and Prevention of Waste"; Mr. F. C. Laurence, "The Effect of Modern Industrial Methods on Employment and Wages"; and Mr. J. F. Butterworth, "Results Achieved in Industry by Modern Methods." The value of knowledge on matters of scientific management cannot, in view of the commercial crisis with which the Nation is faced, be over-estimated, and the League is undoubtedly following an intensely patriotic line in organising such a series of what must inevitably prove useful gatherings. Anyone desirous of attending the conference can obtain full particulars from the Secretary to the Industrial League and Council.

## MEETINGS FOR THE WEEK.

*Monday, February 2.*

Royal Society of Arts, 8. (Cantor Lecture). "Aircraft Photography in War and Peace," by Capt. H. Hamshaw Thomas.

*Tuesday, February 3.*

Royal Society of Arts, 4.30. "Tropical Departments of Agriculture, with Special Reference to West Indies," by Sir Francis Watts.

*Wednesday, February 4.*

Royal Society of Arts, 4.30. "The English Language and International Trade," by Alfred E. Hayes.

Society of Public Analysts, 8. (Annual Meeting). "Investigation into the Composition of the Unsaturated Hydrocarbons in Coal-gas," by F. S. Sinnatt and L. Slater. "Estimation of the Available Oxygen in Sodium Perborate and in Perborate Soap Powders," by H. Trickett.

Advertiser, aged 18, Matriculated 1919, continuing education Birkbeck night College, keenly interested in Chemistry, desires Position in Chemical Laboratory. Now employed in Gas Co.'s Laboratory, but newly-arranged hours will prevent further education.—Letters, S. F., 33, Belmont Road, Beckenham.

Chief Chemist wanted for large Cement Works in India. Must have had wide Cement Works Laboratory experience. Salary up to 1000 Rupees per month for suitable man. Three years' agreement, with passage out and home. Unfurnished quarters, light, fuel, and fans will be supplied free.—Address, C. C., Chemical News Office, 16, Newcastle Street, Farringdon Street London, E.C. 4.

Youth desires Situation in Works Laboratory. Three years' experience with Fine Chemical manufacturers.—Address, Y. H., *Chemical News Office, 16, Newcastle Street, Farringdon Street, London. E.C. 4.*

## NORTHERN POLYTECHNIC INSTITUTE,
HOLLOWAY, LONDON, N. 7.

The Governors of the above Institute invite applications for the Post of ASSISTANT CHEMICAL LECTURER. Must have good Honours Degree. Commencing salary, including War bonus, from £225 to £315 per annum (London County Council scale), according to qualifications and experience.

Particulars and forms of application may be obtained from the Clerk to the Governors.

## TENDERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, February 6, 1920, addressed to the Secretary, H.M. Office of Works, &c., Storey's Gate, Westminster, S.W. 1, for the Supply of MATERIALS AND APPARATUS FOR CHEMISTRY AND TECHNICAL COURSES, including SCIENCE EXPERIMENTS, MENSURATION, HEAT, &c.

Forms of Tender, &c. may be obtained on application to the Controller of Supplies, H.M. Office of Works, &c., King Charles Street, Westminster, London, S.W. 1.

G. R.

**MINISTRY OF MUNITIONS.**

BY DIRECTION OF THE DISPOSAL BOARD (MISCELLANEOUS STORES SECTION).

# FOR SALE.

# GAS CYLINDERS

**IN LARGE OR SMALL NUMBERS.**

## LAP WELDED GAS CYLINDERS.

Length over all, 3 ft. 8½ ins.
External diameter, 8¼ ins. Thickness, 3/ 6 in.
Test pressure, 500 lbs. per square inch.
Water capacity, 62 lbs.
Accepted for Railway transport of 64 lbs. of liquid Chlorine.

Also 18-lb. Solid Drawn AMMONIA CYLINDERS.

40 and 60 cubic feet capacity Solid Drawn OXYGE[N] CYLINDERS.

Admiralty pattern Solid Drawn HYDROGE[N] CYLINDERS.

A number of CARBONIC GAS CYLINDERS.

Full particulars may be obtained on application to th[e] Controller, D.B. 5 c., Earl's Court Exhibition Buildings Earl's Court.

Note.—For particulars of other Government Property f[or] sale see "SURPLUS," price 3d., at all Bookstalls; or b[y] quarterly subscription of 2/- post free, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1.

G. R.

**MINISTRY OF MUNITIONS.**

BY DIRECTION OF THE DISPOSAL BOARD (PLANT AND MACHINERY SECTION).

## FOR SALE BY PUBLIC TENDER.

# DISTILLING PLANT.

TENDERS are invited for the following:—

**DISTILLING PLANT. Capacity, 4 tons of Pruss[ic] Acid per day of twenty-four hours,**

Comprising—

M.S. Stills, M.S. Dissolvers, Acid Tanks, Brick Crusher, Elevator Condensers, Drying Towers, various Tanks, Air Compressors, Fans Lancashire Boiler, Donkey Pump, Feed Tank, various Pulleys Blocks, C.I. Pipes, Valves, &c. One REFRIGERATOR PLANT complete, motor driven, by Lightfoot (Ammonia).

Also CONDENSERS, COMPRESSORS PUMPS, and TANKS

The STEEL BUILDING to house above Plant, constructed of H Steel Girders covered with Eternit sheet, and One WOODEN FRAME BUILDING, also covered with Eternit sheets and Corrugated Iron.

N.B.—The Plant has been partially dismantled, but the Buildings are intact.

*Located at the R.N. Experimental Factory, Stratford, E.*

Full particulars, Permits to View, and Form of Tender can be obtained upon application to Controller, Plant and Machinery Section (D.B. 1 E.), Disposal Board, Charing Cross Huts, Embankment London, W.C.

Tenders to be returned completed on or before 10 a.m. February 7th (Ref G. 1786) M.K. 21912—21943—21981-2.

NOTE.—For particulars of other Government Property fo[r] sale see "SURPLUS," price 3d. at all bookstalls or b[y] quarterly subscription of 2/- post free, payable in advance, to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1.

E CHEMICAL NEWS

VOL. CXX., No. 3121.

## : RAPID DETERMINATION OF CARBON MONOXIDE IN AIR.*

y ARTHUR B. LAMB and ALFRED T. LARSON.

reathing of air containing 1 per cent of carbon mon-
y men in moderate activity will lead to loss of con-
ess within a few minutes, followed very soon by
o·1 per cent of carbon monoxide may cause dis-
nt *in about two hours, and* 0·05 *per cent is suffi-*
o induce drowsiness on prolonged breathing.

testing of the efficiency of gas mask absorbents for
monoxide therefore involves the precise analysis of
ixtures containing 1 per cent and less of this gas.
ver, to follow adequately the behaviour of an
ent during a test, frequent and very rapid analyses
*quired.*

ien testing of this nature became necessary in the

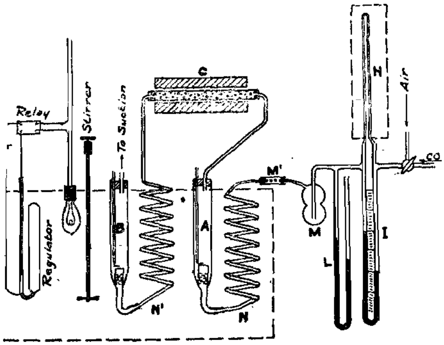


Fig. 1.

earch Division of Chemical Warfare Service, a search
a satisfactory method was made, but none was found at
*e sufficiently accurate and rapid for this purpose.*

Methods depending upon absorption, such as the
rous chloride and the Haldane methods, were out of
question, since the volume changes to be measured at
se concentrations were so minute. Conversion to
bon dioxide and its determination was not suitable
ause of the difficulty of securing rapid and at the same
*e complete absorption of carbon dioxide at very low*
centrations. The liberation of iodine from iodine
toxide furnished a very accurate method, particularly
concentrations of carbon monoxide as low as o·1 per
t, but it was found to be time consuming.

Thermometric methods depending on the rise of tem-
rature produced by the combustion of the carbon mon-
*ide had, to be sure, been described, particularly in the*
patent literature, and they had, at least, the merit of
rapidity. Thus, Guasco had *proposed a differential* air
thermometer in which one of the bulbs was of platinum
covered with platinum black (*Comptes Rendus*, 1912, clv.,
282). The device has been found to poison rapidly,
require frequent calibration, and is not accurate at low
concentrations.

A. and L. D. Williams (U.S. Pat. 1,143 473, June,
1915) had described an arrangement which employs an
electrically heated catalyst in contact with which the gas
*burns, the temperature rise being measured by a thermo-*
couple. Unfortunately, the two thermo-junctions are
separately heated, with the result that the accidental tem-
perature differences at the two junctions introduce errors
which may completely mask any heating effect resulting
from the combustion of small quantities of carbon
monoxide.

Phillip *and Steele (U.S. Pat. 899,068, Sept., 1908)* had
placed a catalytic material on a wire which was made one
side of a Wheatstone bridge, the catalyst being heated by
passing a current through the wire. No provision, how-
ever, was made to prevent poisoning of the active
material; nor is the device sufficiently compensating to
detect the small temperature changes resulting from
carbon monoxide air mixtures of low concentration.

B. T. Tilghman (U S. Pat. 524,361, Aug., 1894) and

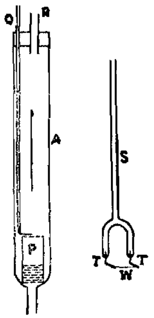


Fig. 2.

H. H. Clarke (U.S., Pat. 960,823, June, 1910) had sug-
gested Wheatstone bridge arrangements in which one
*side of the bridge is heated to a temperature where com-*
bustion of the carbon monoxide takes place. These
methods are, however, not truly differential, and on that
account are of little value for the quantitative measure-
ment of low concentrations of carbon monoxide.

All of the above devices would no doubt be of value in
detection of relatively high concentrations of carbon
*monoxide, as, for instance, in the operation of signals,*
warning of the approach to the explosive limit. They
would also be undoubtedly rapid *in* action, but their
accuracy would be wholly insufficient for measurements of
the low concentrations above mentioned.

Attempts were therefore made to increase the accuracy
of the thermometric method without forfeiting its rapidity,
and *two new modifications of the method were developed*
which met this requirement. Both measure the tempera-
ture rise resulting from the combustion of carbon mon-
oxide in air. In the first method the combustion takes

* Published by permission of Maj.-Gen. W. L. Sibert, Director of
emical Warfare Service, U.S.A. From the *Journal of the*
*erican Chemical Society*, xli., No. 12.

place in contact with a heated platinum wire, in which case the amount of combustion is constant but not complete. In the second method combustion takes place in contact with a platinum catalyst, and is complete. In the first method the temperature rise is measured by a Wheatstone bridge arrangement, which is practically a platinum resistance theremometer; in the second the temperature rise is measured by a thermo-couple.

Neither of these methods is an absolute one; that is, both must be calibrated by the use of carbon monoxide air mixtures of known concentrations. As a consequence the absolute accuracy of these methods depends, in part, upon how accurately these concentrations can be determined either by synthesis, or, as was found more convenient in practice, by analysis. Since these calibrations are but infrequently required and the analysis of the reference gas can be made at leisure, the method employed for the purpose need not be a rapid one, and therefore a slow and very accurate method such as the one using iodine pentoxide can be employed. The absolute accuracy of these new methods can therefore be made equal to that of the best chemical method; since in addition they are rapid, they ought to prove useful in many fields (U S. Pats. 1 321,963 and 1,321,064 have been granted covering these two methods).

*First Method (Hot Wire Method).*

(NOTE.—This method finally proved less advantageous for our purpose than the second method (catalytic method) to be described later. It was therefore not fully developed by us, and can doubtless be brought to a much higher state of perfection. Nevertheless, important details regarding it were worked out; it was put in actual operation, and tests made demonstrated its considerable reliability and accuracy. For this reason a brief description of it and its operation is given. After our work on this method had been completed a valuable paper on this subject was published by Weaver and Weibel of the Bureau of Standards (Bureau of Standards, *Scientific Paper* 334, "New Forms of Instruments for Showing the Presence and Amount of Combustible Gas in the Air"). In this paper important fundamental studies are given of the behaviour of heated wires in air mixtures containing combustible gases. An apparatus is described for determining combustible gases working on a principle similar to the above mentioned first method. It is not, however, as rigorously differential as this method, in that instead of two identical wires, an active and a coated wire are employed. Moreover, it is not certain from the above paper that this apparatus, which evidently operated successfully as a detector at the concentrations studied, would at our ten times lower concentrations operate with the precision required in our analytical work).

In this method (Fig. 1) the air mixture to be analysed is passed over a platinum wire heated to a dull red, in contact with which the combustible gas is partially burned, then through a tube of heated copper oxide where the combustion is completed. The gas mixture, free from carbon monoxide, then passes back over a second platinum wire, not only in itself identical with the first wire, but identically mounted and connected in series with it. These two wires constitute two arms of a Wheatstone bridge, and after being suitably balanced a change in temperature of either wire with respect to the other will cause a change in relative resistance, which is disclosed by a suitable galvanometer. This arrangement, except for the carbon dioxide formed and the slight change in volume, is rigorously differential. To insure identity of temperature in the surroundings and in the gas stream the whole apparatus is submerged in a closely regulated water thermostat, and the gas stream, before reaching the hot wires, is led through long copper spirals similarly submerged.

The most serious difficulty and one which was underestimated at the outset, was the irregular variation in the relative resistance of the heated wires, even when no carbon monoxide was present in the gas stream. Thus these relative resistances were found to vary markedly with changes in the total rate of flow of the gas in spite of apparent substantial identity in the dimensions and shapes of the hot wires and their containers. It was therefore necessary to hold the flow carefully constant by means of a sensitive flowmeter. In spite of these precautions large and irregular variations in the relative resistance of the two wires still occurred, so that the effect of the combustion of small concentrations of carbon monoxide on the first wire was completely masked. The difficulty was finally solved by carefully eliminating eddies in the gas stream. This was accomplished by placing within "P" (Fig. 2) several layers of cotton gauze and covering the end of "P" with a fine-mesh cotton gauze over which the heated platinum wire was directly placed. This gave a steady and apparently stream-line flow and eliminated the marked fluctuations in the relative resistance of the wires.

*Apparatus.*

The apparatus is shown assembled in Fig. 1. The platinum wires ("heaters") are supported within the tubes A and B. C is an electric furnace containing a tube of copper oxide. N and N′ are copper tubes wound in a spiral as indicated. H, I, is a flowmeter, the capillary of which is kept in the thermostat. L is a manometer which indicates changes in the pressure of air within the system. M is a wash-bottle for drying the gas, while M′ is the glass-wool plug which serves to remove acid spray.

An enlarged view of the heater and its containing tube is shown in Fig. 2. Into the glass fork, a, are sealed platinum wires (No. 14) which are bent sharply at right angles, the ends being 1 cm. apart. A slit was cut in the end of each wire, and into this was clamped a strand of platinum wire, W, made by twisting together two wires 0 002 inch in diameter. Satisfactory contacts were made by arc welding the ends of the wire to the support. The fork was held rigidly so that the platinum heater fell just over the mouth of P. A storage battery large enough to maintain the wires at a constant dull red for long periods was used. The current flowing through the bridge was kept constant by means of a slide-wire resistance and a millivoltmeter.

(To be continued).

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## GLASS AND SOME OF ITS PROBLEMS.*

By Sir HERBERT JACKSON, K.B.E., F.R.S.

BEFORE I begin this lecture, I should like to say how much I appreciate the privilege of being asked to give this, the second Trueman Wood Lecture. Our Chairman has stated the origin of these lectures, namely, to keep alive the memory of the long and distinguished work of Sir Henry Trueman Wood in promoting and increasing our knowledge of the arts and sciences in the best interests alike of this Society and of the nation. I am sure I express the feelings of everybody present when I say how delighted we are that he is here to-day, and when I express the hope that he may be able to attend many more lectures to be given in his honour.

It was suggested to me that this lecture should have something to do with glass, and it was hoped that there might be experiments. The production of glass is difficult to illustrate efficiently in the course of a lecture. It will, therefore, only be dealt with very briefly and generally before turning to some of the problems connected with glass which I hope to make the chief part of this lecture. The Chairman, in his opening remarks, has spoken of the many varieties of glass. We hear of optical glass, window

* The Trueman Wood Lecture delivered at the Royal Society of Arts, April 30 1919. Owing to extreme pressure of work, Sir Herbert Jackson has only recently been able to complete the M.S. of his lecture. This accounts for the delay in its publication.

lass, table glass, industrial and scientific glass, opal glass, oloured glass, &c., all of which have many properties in ommon, while exhibiting differences which depend chiefly pon the materials used in making them, the various proortions in which the materials are used, and to some tent also on the methods of manufacture. It will be venient to take window glass as one of the simplest glasses, and briefly to consider its composition. The ential materials required are sand, chalk, and sodium arbonate. When these are heated together in suitable roportions there results a glass containing silica, or the xide of the non-metal silicon, lime, or the oxide of the etal calcium, and soda, or the oxide of the metal sodium, ombined together to form what is generally spoken of as a oda lime silicate. Of these ingredients the silica is the cid constituent, and the lime and soda are the basic conituents of the glass. Most glasses are composed of acids s oxides of non-metals, and bases as oxides of metals ombined together. The chief acid ingredients to be found various glasses are silica, boron trioxide, arsenic ioxide and pentoxide, phosphorus pentoxide, tin oxide, d antimony pentoxide. The chief bases are the oxides f potassium, sodium, lithium, barium, calcium, magesium, zinc, and lead. Aluminium oxide, a constituent f several glasses, may in some play an acid part and in thers may act as a base. With certain reservations, this ay be said also of antimony trioxide. The list is not exaustive, but is sufficient to indicate that a number of asses is possible from various combinations of these acids d bases. (The materials used for producing opals and oloured glasses will be referred to later). The number f glasses made is very large, and it would take at least ll the time at my disposal to describe in any adequate anner how they differ from one another in composition d in those properties which make each one suitable for e purpose for which it was devised. It may, however, e appropriate here to mention that in the great variety of ptical glasses there are many which do not differ materilly in composition from glasses used for other purposes. or example, a good window glass could be made with are materials and stirred in the process of its manuacture, so as to secure such a clear and homogeneous roduct as would serve as one type of optical glass. The hief general properties which are desirable in all optical lasses are identity of composition throughout the whole ass of the glass, great clearness and transparency for all e colours of the spectrum, freedom from strain arising rough imperfect annealing, and durability under rdinary exposure to the atmosphere. It will be seen, erefore, that apart from considerations of special optical roperties—I refer to the refractive indices and dispersive owers of various optical glasses—the main difference etween them and other glasses is that the highest art of e glass manufacture is called for in their production, d great care is needed to ensure purity of the materials sed and accuracy of proportions, so as not only to be ble to produce glass of the optical properties required, but reproduce it with the closest possible identity of comosition. With these very brief remarks on glass generally, e may turn now to some of the problems which I thought ight be interesting to consider, and the first one is how r can glass be called a solid?

A solid is defined in a dictionary as having a fixed form, d being in a state in which the component parts do not nd to move freely among themselves. With regard to lass, we may ask for how long is it fixed in form, and hat are the limitations of freedom of movement which we ught to consider? It is a common experience that long raight pieces of glass rod or tubing, left supported so at their own weight tends to bend them, will bend in the ourse of time, and in some years will become definitely owed. Varieties of glasses differ in the readiness with hich they show this flow under stress; but not any glass so perfectly solid as to give no indication of movement nder stress if tested by sufficiently delicate means. This estion of permanent stability of form in glasses has some bearing on the choice of glass for the manufacture of large lenses and prisms, and the flowing of the surface of glass under mechanical pressure comes in as a very important matter in the explanation of the mechanism of polishing glass surfaces. A great deal has already been written on this subject, and it would take too long to deal with it here. Another reason why I refer to it but intend to leave it is that I hope it will not be long before the published papers and other work of Sir George Beilby, on the influence of mechanical disturbance on the physical state of a very large number of substances, will be brought together into one connected story, when it will be seen that this subject of polishing glass has been dealt with in a comprehensive manner, and that the principles underlying it are shown to have very wide application.

The question of the relative plasticity of various glasses has two important bearings which are of some interest. For many industrial and scientific purposes it is necessary to be able to seal metallic wires into glass, and early in the war some difficulties were experienced in obtaining suitable glasses. To obtain successful joints between the metal and glass without fear of the latter cracking it was generally considered that the glass aimed at should be one which had a coefficient of expansion as close as possible to that of the metal intended to be used, and there is no doubt that this question of expansion has to be taken into account. In making a large number of glasses and in experimenting with them there did not appear to be that close connection between the coefficient of expansion of the glass and its behaviour with metal wires which was at first expected. The coefficient of expansion of copper is about double that of platinum, and the coefficient of iron is about midway between the two. Glasses were made which gave successful joints with platinum and copper* wires, but which cracked inevitably with iron wire. It did not appear, therefore, that the coefficient of expansion was the only factor to be taken into consideration. It is an important factor, but not the only one, and it soon became clear from the study of various glasses that the plasticity of the glass had a great deal to do with its utility. A careful examination showed that there was evidence that in the case of soft metals, like copper and platinum, the glass in setting could pull and deform the metal wires so that no great strain was permanently left in the glass. With hard metals like iron and tungsten it was necessary to devise a glass which had marked plasticity over such a long range of temperature that when the glass and metal joint cooled, the glass would flow and follow the contraction of the metal, and so the stress would to some extent be relieved. And this is an example of the need of asking the question: Is glass truly a solid, and how far can a glass be made which will flow, very much less, of course, than pitch, but in an analogous manner? The other bearing of the question is on the cracking of glass vessels with rapid changes of temperature. It is clear that if the strain set up by such changes can be quickly and readily released, the danger of cracking will be very small. The coefficient of expansion is, of course, a very important factor in this respect. It is well known that vitreous silica vessels can be heated to redness and plunged into cold water without cracking, and this is, no doubt, correctly considered to be due almost entirely to the low coefficient of expansion of silica. In the case of glasses also the lower the coefficient of expansion of a glass the better will that glass stand rapid changes of temperature. But it is possible to make glasses approximately with the same coefficient of expansion and to find one—and that perhaps the one with a slightly higher coefficient of expansion—which will not crack under conditions in which the other cracks readily, and a study of the two glasses shows that the more stable one is the more plastic. On the whole, perhaps, it is not too much to say that glass may be looked upon as an extremely viscous liquid, so slow in its movements in some types of glass that ages might elapse before any marked change in form could be observed under a strain just short of a*

breaking one for the glass, while in others it is possible to show that the glass does flow, even at the ordinary temperature, to a small extent in a relatively short time.

The next problem to be considered may be also put in the form of the question: Is glass truly amorphous or vitreous, or has it any crystalline structure or tendency to crystalline structure? There are many substances which can be obtained in the vitreous state and also in the crystalline state, and which can be changed from one to the other. As one example, arsenic trioxide may be mentioned. It can be produced as a clear transparent glass which slowly changes at the ordinary temperature into an opaque white substance resembling porcelain in appearance. The opaque white substance is crystalline. It is the crystalline variety into which the vitreous will be slowly but completely changed. Again, if sulphur near its boiling point be poured in a thin stream into cold water it sets as plastic threads, and for our purposes we may speak of this as the vitreous form of sulphur. Left at the ordinary temperature, it slowly changes into the crystalline form.

Two other examples may be given which in a way are perhaps more closely analogous with glass, since they are solutions of substances, and not merely single substances as in the previous illustrations. Solutions of sodium acetate and Rochelle salt, obtained by adding to hot water as much of the salts as will dissolve and cooled so that no unfiltered air can enter the containing vessels, and carry nuclei to start crystallisation, remain clear and fluid at the ordinary temperature. If such a "supersaturated" solution of sodium acetate be cooled in liquid air it is converted into a vitreous solid quite clear and transparent. On removal from the liquid air its temperature rises, and very soon crystallisation starts and proceeds right through the vitreous mass. The solution of Rochelle salt treated in the same way yields a similar vitreous mass, but as it warms up no crystallisation takes place. It slowly goes back to the original liquid condition. The cold vitreous sodium acetate solution may be taken as analogous to a glass from which crystals readily separate on warming up, while the Rochelle salt is analogous to a glass which shows no tendency to crystallise through the whole range of temperature from the solid form to the point at which it is a mobile liquid. Glasses are known which tend to crystallise in all degrees of readiness. As a simple glassy substance, zinc silicate may be taken. It can be obtained, by moderately quick cooling of the molten mass, in a vitreous form which is stable for a number of years—at least some has remained with no sign of crystallisation at the ordinary temperature for twenty-two years. By heating to a few degrees above its softening point it changes to a translucent crystalline mass. Taking a more complex glass, but still a moderately simple one, we may study the behaviour of heat on a lime soda silicate glass. The specimen of greenish glass with some large and many smaller opaque nodules in it was given to me in the early part of the war by Mr. Frank Wood as an example of glass taken out of a tank furnace. The nodules are calcium silicate, which is the least fusible silicate potential in the glass. They have been formed through the glass in the particular part of the furnace from which it was taken being at a temperature too low to keep this silicate in solution or combination, and it has separated out in the form shown. To get this glass back to a complete vitreous state again would require a somewhat higher temperature than is used in the manufacture of the glass, since the calcium silicate is itself very infusible, and the rest of the glass has to be made very fluid before such masses of this silicate can be dissolved in any reasonable time.

This glass then, in a molten state, is an example of a solution out of which a slightly soluble constituent has separated, when the conditions were suitable for that separation. It may be interesting to turn for a moment to a consideration of conditions for crystallisation, and to go back to simple glassy bodies such as zinc silicate and some borates. With all the vitreous substances which have been tried and have been made to crystallise there is a certain temperature at which crystallisation proceeds readily, and for small ranges above or below that temperature no crystallisation occurs. Associated with alteration of temperature there is change in the viscosity of the vitreous substances, and hence in the freedom of movement of their particles among one another. The effect of this can be well seen when a crucible full of molten zinc silicate is removed from the furnace. If the mass be small so that cooling is quick, it remains a glass and has to be re-heated before crystallisation occurs. With a larger quantity, and consequently slower cooling, the mass may become wholly crystalline, or only partly so if some of the vitreous form reaches a temperature at which its viscosity is too great, and freedom of movement of its particles too small for rearrangement into crystals to take place. Some borates are very convenient for illustrating the change from the vitreous to the crystalline state. Boric anhydride itself has not been made to crystallise, and, as might be expected, the greater the proportion of it in a borate the less marked is the tendency of a fused mass of that borate to crystallise on cooling. Of the three borates, $CaO.2B_2O_3$, $CaO.B_2O_3$, and $2CaO.B_2O_3$, the first can be obtained vitreous by fairly quick cooling, and pieces of it can with care be heated again to remove the strain produced; that is to say, it can be annealed. The second crystallises from fusion much more readily; cooling has to be quicker to keep it in the vitreous state, and only small glassy pieces can be obtained, which crystallise, however, on attempting to anneal them. The third borate can only be kept vitreous in very small globules.

Statements, however, of the bulk which can be obtained of any readily crystallisable vitreous body require a certain reservation. It is well known that crystallisable bodies in the fluid state may be cooled considerably below the temperature at which they would ordinarily solidify to a crystalline mass if they are freed from all foreign material. Water is a well-known example, and among many others which could be cited mention may be made of salol (phenyl salicylate). It melts at 43° C., and if the crystallisation of a film of the molten liquid be watched under the microscope numerous small bubbles of gas can be seen to form during crystallisation. The gas appears to be modified air. If salol be melted, allowed to solidify, and remelted in vacuo, so as to remove all this gas, and the process repeated several times, it is found that the molten salol must be cooled many degrees (fifty or more) below its melting point before crystallisation takes place. A small crystal of salol will start it, unless, as can be done on small quantities, cooling has been carried far enough to increase the viscosity of the fluid to such an extent that the particles have not the freedom of movement necessary for the change to the crystalline form. So it is also with a great number of glassy bodies, and the bulk which will retain the vitreous form can be largely increased since by fusion and crystallisation several times they solidify at progressively lower temperatures, until the time comes when they get quite cold in the vitreous state. For instance, the amount of vitreous zinc silicate obtained has been raised from twenty grms. at one heating up to a kilogrm. by five fusions. The calcium borate $2CaO.B_2O_3$ has, after several fusions, been cooled to 500 degrees below its ordinary solidifying point. When it does crystallise and the temperature rises the recalescence is remarkably bright. Long-continued heating a few degrees above their solidifying points similarly retards the crystallisation of many vitreous bodies, but it is not so effective as the alternate fusion and solidification. One reason at least is not far to seek, if the two processes be tried so that gases evolved can be pumped off and their amounts measured. The process with alternations yields much more gas in any given time. With all the glasses, simple silicates and borates, which have been studied so far, the chief gas evolved has been found to be water vapour, and with the progressive removal of it the vitreous state has been found to persist more and more. Direct introduction of water

sequently has been found to promote ready crystallisa-
i..

ı connection with the comparison of long continued ting of a melt with alternate fusion and solidification, extreme instance is worth noting. For a special ical glass, rich in phosphoric anhydride, an experiment ; tried with ammonium phosphate to find if this sub-ıce could be used in the batch mixture for the glass. A ɛ clear fluid melt was obtained, which was kept fluid for eral hours after all traces of gas bubbles had gone. The lt was well stirred and cooled till it was quite viscous, en it was left to get cold slowly. The next morning furnace top was found forced off and resting on a ıngy mass of about thirty times the volume of the ginal glass melt. The changes occurring when solidifi-ion was approaching had evidently been accompanied the evolution of a large volume of gas, no doubt most it ammonia, since this substance was smelt on grinding : spongy mass up. The ground material was then fused, ɟ gave a stable glass.

ƎReverting to the question, Is glass truly vitreous, or is ɜre evidence of any crystalline structure in it? and aring in mind that glasses are known which exhibit all ıtes of preparedness to yield crystals at some temperature other, and that the tendency to the segregation of some ʒredient of a glass is enhanced by the presence of small ıounts of foreign substances, and notably of water, one ould rather expect to find a good many glasses in which me evidence could be discovered of the early stages of derly arrangement of particles towards the crystalline rm. So far, etching glass surfaces with hydrofluoric id has failed to reveal any of the network of crystalline ructure filled in with vitreous material which is some-nes described as representing the texture of glass. earing the surface of glass by letting a film of strong ue dry and contract on it is also stated to reveal a ystalline network. Both the etching and this method ve markings very like a network no doubt, but the guring of the surface seems to be more correctly ascrib-ble to surface tension. Nothing which could be called efinite evidence of crystalline structure is visible with any ind of illumination under the microscope of such surfaces; at this is not to deny that the texture of some glasses may e that of a network of crystalline compounds enclosing itreous bodies.

Certain facts, from which it appears reasonable to onclude that many glasses have something of a crystalline ıature in them, have been obtained from a study of the ›hosphorescence of various glasses and other vitreous :ompounds exhibiting different degrees of readiness to ıass into the crystalline state on heating. Much of the vork was done about twenty years ago, but more recent :xperiments have not modified the conclusion then formed .hat a truly vitreous body exhibits no phosphorescence in ıltra violet light or X rays or under cathodic discharge. Nearly every glass shows some phosphorescence, and some show it very strongly, as, for example, the glass from which X-ray bulbs are largely made, and which gives the well-known green glow when the tube is in use. If some of this glass be fused and very rapidly chilled, as, for example, by making a Rupert's drop from it, the glass is practically non-phosphorescent so far as its surface is concerned. A very little distance below the surface the chilling was not sudden enough to prevent some change of the truly vitreous to an attempt at crystalline structure, so that just below the surface, as shown by broken pieces of the drop, the glass exhibits phosphorescence. The tail of such a Rupert's drop, if heated below the temperature at which the thin thread of glass bends, is found to be strongly phosphorescent, and the glow under cathode discharge can be seen to fade slowly away towards the part which was not heated. Many observations with vitreous borates and silicates have shown similar phosphorescence, appearing more and more strongly as the vitreous bodies are made to approach the crystallising stage. There does seem, therefore, reason to state that, given a body which in its crystalline state exhibits phosphorescence, it will not do so when it is in a truly vitreous state, and to infer that if a glass be phosphorescent there is something of a crystalline nature it it. It would not be right to come to the conclusion that a glass showing no phosphorescence is free from anything crystalline, since there may be crystalline structure in in which is not in the sensitive state to be revealed by phosphorescence. It would take up too much time to elaborate this further; but generally it may be said that a number of experiments on glasses, borates, &c., go to show that in some non-phosphorescent glasses there is most likely some crystalline formation, since the introduction of minute amounts of certain bodies not usually present in these glasses as manufactured will render them quite markedly phosphorescent; and, again, the surfaces of Rupert's drops made from these sensitive glasses show no phosphorescence. Before going on to deal shortly with some points about devitrication, I may point out that boric anhydride, which has a marked effect in preventing crystallisation in glasses and in enhancing the stability of the vitreous form, is a fatal ingredient to add to a uranium glass if strong fluorescence in ultra violet light be aimed at.

It may be concluded from what has been said or suggested that the question whether glass is crystalline or not has a bearing on the problem of devising, manufacturing, and annealing optical glasses. It has perhaps a more obvious bearing on the problem of producing glasses capable of being freely worked in a furnace or in the flame of a blowpipe. To the flame worker especially a glass prone to devitrification is a source of trouble. It would take at least a whole lecture to deal adequately with all the changes noticed in the numerous types of glasses which have been studied for their behaviour in the flame. I will confine myself merely to mentioning that the segregation of less fusible vitreous bodies giving a kind of crinkled skin to the glass, separation of amorphous silicates, the formation of very minute bubbles giving a grey look to the glass, as well as true crystallisation, are all frequently referred to as devitrification. It is mainly about the last form of it that there is time in this lecture for a few remarks.

There is great variety in the behaviour of glasses in a flame. A soda lime silicate can be made which is hardly workable at all in the flame—it devitrifies so soon; but the same glass may be worked if heated by radiation—for instance, in a muffle furnace. At the same time it must be understood that exposure in the muffle may bring about devitrification even quickly if the temperature is such as to bring the glass to the right state of fluidity for rearrangement of some of its particles in the crystalline form. It would appear, therefore, that the difference between the behaviour of the glass heated in the flame and heated by radiation may be explained by the difference in temperature reached by the glass in each case, and no doubt this is a most important part of the explanation. Recalling what was said, however, about the conditions for crystallisation of vitreous bodies, there is, apart from temperature, the question of purity to be taken into account. The problem is whether the readier devitrification of a glass in the flame can be ascribed solely to the surface of the glass being exposed to a very high temperature, and so for a thin layer reaching the right state of fluidity for crystallisation, or whether chemical action also plays a part, *i.e.*, whether the hot gases of the flame act on the glass and assist the segregation of parts of it by disturbing the chemical equilibrium of the bases and acids of the glass. Attempts to get an exact reproduction of the behaviour of a glass in a flame by exposure of thin pieces of the same glass to intense heat by radiation have given results showing close similarity in some glasses and great differences in others. It would be somewhat out of place, and certainly tedious in a lecture such as this, to go into the details which seem to justify the statement that a survey of the relative behaviours of a very large number of different types of glasses exposed to flames or to heat by radiation, and chemical examination of the products, leads to the con-

clusion that water, and to a smaller extent carbon dioxide, do act chemically when many glasses are heated in flames, and that this action plays an important part in the initial stages at least of devitrification. As the most simple example which I can choose of marked difference in composition of a glassy body heated by radiation, or in a blowpipe flame, ordinary borax ($Na_2O.2B_2O_3$) may be taken. Heated in a muffle up to about 1450° C. until much of it has volatilised, the residue may, according to the time of heating and the temperature, have a composition represented by anything between $Na_2O.8B_2O_3$ to $Na_2O.15B_2O_3$; but it has not been found possible under any conditions in a blowpipe flame to get a residue from borax with the proportion of boric anhydride greater than is represented by about $Na_2O.3B_2O_3$. It is difficult to ascribe this difference solely to the effect of different temperatures. With some glasses, however, there is visible evidence of the disturbing influence of the hot gases of the flame. A glass containing barium oxide, which was heated and re-heated many times by radiation of varying intensity, and which was most reluctant to show any signs of crystallisation, became in the blowpipe flame or in a hydrogen flame grey at once over its surface, and soon afterwards signs of crystallisation were readily noticeable. The initial grey effect was seen under the microscope to be due to numerous very minute bubbles caused apparently by the rapid absorption and subsequent evolution of gases. As the question considered here is the influence of the hot gases of a flame to hasten devitrification, there is no occasion to discuss the well-known effect of an ordinary blowpipe flame to blacken glasses containing lead or similarly reducible metals, except to say that experiments show that in many instances the process of alternate reduction and oxidation which sometimes occurs when such glasses are being worked in the flame does also appear to hasten devitrification.

Mention was made above of the influence of boric anhydride to retard the crystallisation of glasses in which it is an ingredient. Alumina is another substance the presence of which confers upon a glass the property of working well in the flame without devitrification. More striking perhaps as a vitrifying agent is titanic oxide. A soda-lime silicate glass was made which could not be worked in a flame at all, so readily did it devitrify. The substitution of a small amount of its silica by titanic oxide converted the glass into one which could be heated and worked in the flame almost indefinitely without visible change. The statement "without visible change" is true of the behaviour of this glass; but some, and notably very soft glasses containing titanic oxide, become coloured in the ordinary blowpipe flame through reduction of this oxide to a lower state of oxidation. Zirconium, tin, and thorium oxides have been found to promote the stability of the vitreous state in a number of glasses prone to devitrification in the flame. They are mentioned as being of the same chemical family as silica and titanic oxide; but to deal with the effect of a number of rarer compounds not generally employed in glass making would take up too much of the rest of the time at my disposal. Arsenic and antimony oxides may also be put among substances which render glasses less liable to devitrification; but glasses containing these oxides are not suitable for ordinary working in the blowpipe, since they darken in the reducing area of the flame. Tin oxide, mentioned above, is also not a generally suitable ingredient, since some glasses containing it darken badly through reduction in the flame, though others can be made which are quite workable except in the hottest kind of blowpipe flame.

I must leave out of consideration the relation of general composition and of varying proportions of ingredients to the tendency of glasses to devitrify, and content myself with the remark that for glasses of comparable composition those containing soda only as the alkali are usually found to devitrify more readily in the flame than those in which the alkali is potash, or a good proportion of potash, with soda.

(To be continued).

THE
## USE OF ELECTRICITY IN AGRIC
### WITH SPECIAL REFERENCE TO ITS DEVELOP IN GERMANY.

By JOHN FRANCIS CROWLEY, D.Sc., B.A., M.I.E.

(Concluded from p. 52).

### DISCUSSION.

THE CHAIRMAN (Sir William Barrett, F.R.S.), in openin the discussion, said he had listened that afternoon to most interesting, practical, important, and lucid pape The author had had the great advantage of being co nected for many years with the great firm of Siemens one of its foremost members, and therefore had had unusual opportunity of seeing what electricity had do in Germany, and the many directions in which it had be applied there. Germany had taught us many things, we know to our cost, and not the least had been the grea part that science played in the education of all classe throughout Germany, and the very small part it ha hitherto played in our education in the British Isles. W had begun at the wrong end. Instead of starting abov and working downward we had tried to force our scienc from below upwards, by establishing technical schools f workmen throughout the country. It was not until em ployers recognised the extreme value of all applications o science, and especially of electricity, in their differen forms of industry, that they would be found selectin skilled men and finding the value of the men who ha been trained in our technical schools. The audience ha had that afternoon a striking and comprehensive view o how electricity had been used in agriculture, not only fo the purpose of lighting but of power and of transport, an in various other mechanical ways. Some of the facts an statistics which Dr. Crowley had given were new and wer of extreme value. They made one ashamed of how littl had been done in this country and especially in Ireland, o which country the author was so brilliant a son. H might remind the author that seventy years ago Sir Rober Kane, in his "Industrial Resources of Ireland," ha pointed out how much Ireland could contribute to th industries of the United Kingdom if only its availabl natural sources of power were utilised, especially i water-power, *e.g.*, at Killaloe. There was a source o water-power which probably could be made use of, and t which he (the Chairman) had drawn attention in 1901 i his inaugural address to the Irish Electrical Engineer Water in our towns and cities was used for drinking an cleansing purposes, but not for its p wer. Water distri buted through mains possessed energy as well as matter In the excellent water supply of Dublin a system o lowering reservoirs was used to reduce the pressure o the water from its original source down to the pressure a which the pipes would carry it for distribution throughou Dublin. In all of those successive and numerous reser voirs, the water poured in in an endless stream, and th power was entirely wasted. Why should it not be utilised In his address he had given the amount of power tha could be obtained in Dublin alone in that way. The mos important fact which the author had brought out wa perhaps that as labour went on increasing in price an became therefore more difficult and costly to obtain electricity would become a more and more important facto not only in economising labour, but in extending th hours of labour by its use at night. One aspect of th problem had only been casually alluded to by the autho namely, the use of electricity in stimulating the growt of seeds and accelerating the growth of plants. Abou twenty-five years ago an ingenious Irishman had come t him (the Chairman) about the matter. The man ha erected a number of wires across a portion of his arabl

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[illegible] quently [illegible] ected them with tall poles, and he had [illegible] ad increased in that portion of the field [illegible] con [illegible] ther portions, and he had thought this had [illegible] electricity. *He* (the Chairman) *had repeated* [illegible] ment on ground of his own, one controlled plot [illegible] without wires and another plot with wires. He [illegible] use any artificial sources of electricity, and both [illegible] ere planted with potatoes and manured in exactly [illegible] ne manner. Curiously enough he did find over two [illegible] ee years a 20 per cent increase of potatoes was [illegible] on the wire-covered plot as compared with the plot [illegible] was not so covered. That result had been confirmed [illegible] ter experiments, although some years had been very [illegible] better than other years. Sir Oliver Lodge's experi[illegible] had tended to show that the direct application of [illegible] icity to the growth of crops did really increase the [illegible]

[illegible] F. S. COURTNEY (Consulting Engineer to the Royal [illegible] ltural Society) remarked that perhaps the most [illegible] point about the paper, or at all events that which [illegible] d appeal most to the agriculturists, was the statistics [illegible] of the rapid increase in the application of electricity [illegible] griculture in Germany. He (the speaker) was quite [illegible] that the English farmer was not at all apathetic or [illegible] to move in the adoption of any machinery once he [illegible] perfectly satisfied that he was going to benefit by it. [illegible] farmers had given up their steam engines readily and [illegible] ngly the moment they had been convinced that the [illegible] nal-combustion engine was a more convenient and [illegible] *omical proposition under given conditions for very* [illegible] mittent work, and the farmer would do the same with [illegible] combustion engine the moment electricity was avail[illegible]. What must be looked forward to was the develop[illegible] t of electricity from the big central stations at the [illegible] -producing centres. There were some cases where a [illegible] might advantageously generate his own electricity, [illegible] cially where there was water-power; but the agricul[illegible] t would not put down a plant himself to generate his [illegible] tricity. He could not do it at a remunerative price, [illegible] be had not the staff with which to do it. He had to [illegible] to a generating station. With water-power, of [illegible] se, it was a different matter. On that question, no [illegible] ot there was ample opportunity in this country to utilise [illegible] ry large number of powers. There were many old [illegible] sed flour-mills absolutely doing no good at all. He [illegible] d give an instance of one of them, which a friend of [illegible] had bought. His friend wanted to know if he could [illegible] *him in the way of finding a new tenant for his mill.* [illegible] had told his friend at once that such mills were of no [illegible] to anybody; that the corn all went to the larger mills. [illegible] had advised his friend to instal an electric light plant [illegible] e mill. This advice was followed, and the plant had [illegible] *running* for about fifteen years. There was about [illegible] h.p. there. His friend ran about six hundred lights; [illegible] had got a herd on the home farm of ninety-seven head [illegible] cattle; he did all his chaff-cutting, all his food pre[illegible] ation, his saw benching, the pumping of the water for [illegible] estate, and he also had a fire engine centrifugal pump [illegible] ch gave a couple of hundred feet pressure whenever [illegible] ted by the mere turning on of a switch. One of the [illegible] t useful adaptations in the country for country houses, [illegible] re there was an electric light installation, was to have [illegible] igh pressure centrifugal pump, because the pressure [illegible] ld not be increased beyond a certain point that the [illegible] p was built for, and the pressure was available by the [illegible] *e turning on* of a switch. *Referring to the question* [illegible] ploughing by electrically-worked machines, he trusted [illegible] those who were studying that point would not forget [illegible] history of the Fowler double-plough system. In 1871, [illegible] n he (the speaker) had been at work on the trials of [illegible] m *ploughing gear* at Stafford and Wolverhampton, [illegible] roundabout system had been in competition there. [illegible] the smaller farmers it certainly looked a very promis[illegible] system. What had become of those roundabouts? [illegible] y few of them were seen now. He had been talking [illegible] year to one of the makers of those roundabout systems, and had asked him what had become of them. The maker informed him that, having a roundabout set and a double-engine set of ploughing tackle, which he used *to hire out, working in the same parish, he had* found that on starting on the same day the double set got about eighteen acres start of the roundabout; it had taken that time to get the tackle fixed and started, and consequently he abandoned the system. He knew a friend who had bought a double set of tackle after the Wolverhampton trials, and they were at work now, and when he had inquired last year what they were doing, he had been informed that fortunately just before the war *his friend* had sent his two engines back to the makers to have new boilers, and this time last year his friend had said that the engine was working just as well then as it was when it was brand new. That was a life which could not be ex*pected from the present-day tractor. The electric motor* for ploughing had a very great advantage over any reciprocating engine. There were no reversals of strains. There was a rotary motion; one got straight away on to the drums, and the work was very much steadier and more uniform. It was also very much easier to design a good electric winch than a really smooth working reciprocating engine set. For intermittent work, of course, electric power would have a very great advantage, and the value of electric lighting on a farm was a very important matter, but one had to be careful to have special fittings for lighting in farm buildings, especially in stables, because with ordinary fittings the ammonia would cut *them to pieces in a short time.*

Mr. J. S. DOW thought the application of electricity to agriculture on a large scale was essentially a matter of transmission of energy; it would remain limited so long as farmers had to generate their own supply, and on the small *farms in this country the expense of such individual* effort was a serious item. It was necessary, therefore, to plan out the distribution of energy with courage and foresight, as had been done in Germany and the United States, in the expectation that eventually a paying load would be secured. It must also be remembered that most agricultural operations were intermittent. Small farms might not be able to afford the cost of the electric windlass system of breaking up new ground, but there was no reason why such machines should not be loaned out to a number of farms, if electric supply was generally available, and connections could be made through mobile transformer-wagons, as Dr. Crowley had explained. He *believed it was accepted on the Continent that really* deep ploughing on stiff ground could not be achieved by a tractor which had both to break the ground and propel itself. Hence the advantage of the electric windlass systems, which seemed little known in this country. The machines of German design were powerful but heavy; *in* the French type an attempt had been made to secure less weight and greater mobility, a very important factor. Dr. Crowley had only referred incidentally to direct electro culture. Promising experiments had been made in this country, and he would like to know what results had been achieved abroad. High tension discharges for such work could surely best be dealt with by centrally generated power *distributed over a large area, instead of each field* or fields being treated by the individual farmer. Once electrical supply was available agricultural loads could be combined with other special local operations, such as peat-extraction. Electric transport was almost as important to *the farmer as electric light and power. In the south-*western district of Ireland he had been struck by the small number of farms and the few people employed; often by far the greater number of a family had emigrated. This was popularly ascribed to the fact that the soil was poor and the farms would not support a large family. He was inclined to think, however, that if better facilities for bringing products to market were available in such remote regions, agricultural operations would be pursued with greater vigour and the output would be greatly increased.

Mr. D. J. WILLIAMS remarked that all were agreed that

any step taken towards increasing the production of food at home was of national importance, and no doubt the more extensive use of electricity in agriculture was a step in that direction. It was difficult to predict the future prospects of agriculture, as after the Napoleonic wars there was great depression in this country, while on the other hand a period of prosperity followed the Crimean War. Agriculture had been allowed before the war to drift into a most unsatisfactory condition as far as this country was concerned, and some steps would have to be taken to regenerate it. The price of land had been steadily on the increase, labour was scarce, and wages were high, and the prices of feeding-stuffs and artificial manure were abnormally high, and though the farmers' gross receipts were substantially increased during the war it was questionable whether the average farmer was better off financially, and a good number were perhaps worse off than in an average year before the war. He considered that the author's paper was most timely, as showing the extent to which electricity nad been applied in Germany, where the subject had been studied with great thoroughness. The author had mentioned big central stations to supply power to farmers, but it might be some years before those central stations would come into being. In many parts of the country, however—for instance, in Wales, small water-power schemes could be economically developed for agricultural purposes. The United States Geological Survey Engineers had made an estimate of the waterfalls capable of developing 1000 h.p. and upwards which were unused in that country, and came to the conclusion that a minimum of 30,000,000 h.p. could be developed for four months in the year and double that power for the other eight months. It was not, however, the 1000 h.p. units that he (the speaker) had in mind, but the small streams and rivers all over the country that were at present going to waste, and which ought to be harnessed for the use of the farmer and the public generally. Very little power was required to supply the homestead with clean, cool, and safe light in place of the dangerous oil lamps and candles in common use, as the author pointed out. Less than 1 h.p. of energy would light the homestead; less than 5 h.p. would provide light and small power. Every 4000 gallons of water that fell one foot in one minute, or 400 gallons that fell ten feet in one minute, or forty gallons that fell 100 feet in one minute, meant 1 h.p. When it was realised that 250 cubic feet of water a minute falling ten feet would supply the average farm with light, heat, and small power, the possibilities were enormous. There were several installations in North Wales averaging some 3·5 h.p. used for farm lighting. Another aspect of the matter was the question of the stimulation of plants by electricity, either by direct action on the plant or by indirect action in the soil. That had long been a favourite field of investigation, and it was on record that as far back as 1783 the Abbé Berthelon carried out some experiments in that direction. There were several investigators studying the problem at present, and the results were awaited with much interest.

The Author, in reply, said he found himself very much in agreement with the remarks of Mr. Courtney, who had referred to the fact that the farmer of this country was enterprising when he was satisfied that he had got a good article. With that all must agree, because one must feel that after all what a body like the Royal Agricultural Society did was but an expression of the mind, &c., of the farmers themselves. There could not be an enterprising Royal Agricultural Society if there was not enterprise among the farmers. The steam plough got a very fair trial from farmers, and the internal-combustion engine was aken to very readily; and he had no doubt that if the condition mentioned by Mr. Courtney was fulfilled, namely, that electricity should be made available in the rural districts, farmers would use it. The real problem, therefore, was the provision of that electricity, and, he hoped, under the new Electricity Bill, which would make provision for big stations, a great development in that direction would be seen. But he still believed that in the co-operative movement among the farmers themselves was the real solution, because they were the people primarily interested, and if they took steps to act co-operatively somebody would be enterprising enough to provide the electricity. He thought water-power ought to be developed; but he felt that it would be difficult to induce the farmer to develop small plants, and that it would be much easier to induce him to put down motors if the electricity supply were available. He also agreed with regard to the advantages of rotary motion as against reciprocal. The universal experience in Germany had been that there was a greater production of material from threshing machines with electric driving—that was rotary motion—than there was with reciprocating driving by steam. Mr. Williams' remarks had been of great interest and that gentleman's experience in North Wales clearly showed that small powers could be economically developed in rural districts, and if the farmers would develop them they would be of great help.

On the motion of the Chairman, a vote of thanks was accorded to the author for his interesting paper.

## THE ELECTRO-CHEMISTRY OF URANIUM AND THE SINGLE POTENTIALS OF SOME OXIDES OF URANIUM.*

By CHESTER A. PIERLÉ.

(Concluded from p. 56).

### III. Summary of Results.

The conclusions drawn from the experimental results briefly stated, are—

1. In aqueous solutions with low current density uranyl salts deposit first the hydrated uranic oxide $UO_3H_2O$ which is later changed by the action of current to a black oxide of varying composition.

2. With higher current density uranyl sulphate is reduced to uranous sulphate, but in the presence of free acid the deposit obtained is small in amount and poorly adherent though metallic in appearance. In neutral or alkaline solution, the deposit formed is a mixture of the black and yellow oxides.

3. The use of a porous cup as a diaphragm does but little good. The deposit is the same in character as when no diaphragm is used.

4. The deposit obtained when alkaline uranyl tartrat and citrate solutions are electrolysed is an oxide much richer in uranium than that deposited from solution acidified with tartaric or citric acid.

5. The conductivity of non-aqueous solutions of urany salts is a function of the water present, and the deposit formed are oxides contaminated with organic matter.

6. Anhydrous pyridine treated with anhydrous uranium tetrachloride forms solutions conducting electricity. From these deposits a compound containing uranium and pyridine may be obtained on the cathode.

7. Anhydrous acetone, when used as a solvent for uranium tetrachloride, gives a solution which conduct well but deposits no pure metallic uranium. The deposi replaces mercury from mercurous sulphate. The uranium tetrachloride reacts with acetone forming 2,2-dichlorpropane and also further decomposes acetone. Hydrogen i evolved during electrolysis of the solution.

8. Solutions of potassium uranyl fluoride, whether neutral, acid, or alkaline, form a deposit containing fluorine. In acid solution the deposit is $UF_46H_2O$ Neutral and alkaline solutions give a mixture of $UF_4$ and uranium oxide.

9. Deposits from double potassium uranyl cyanide solutions, when neutral, consist of potassium uranat

* From the Journal of Physical Chemistry, xxiii., No. 8.

TABLE VII.—*Results of Potential Measurements of some Metals and Oxides.*
(Values taken from "Landolt-Börnstein").

| Chain. | Observer. | Form. | Value given. | Value found by pasting with gelatin. |
|---|---|---|---|---|
| $ZnCl_2N/1//KCl.Hg_2Cl_2N/1/Hg$ .. .. .. .. | Neumann | Cast | 0·5030 volt | 0·5026 volt |
| $CuSO_4N/1//KCl.N/1Hg_2Cl_2/Hg$.. .. .. .. | Neumann | Plated | −0·515 volt | −0·516 volt |
| $AgNO_3N/10KNO_3N/1//KCl.N/1Hg_2Cl_2/Hg$ .. | Kahlenberg | Plated | −1·018 volt | −1·0024 volt |
| | Egli | Plated | −0·993 volt | |
| $O_2/Mn(NO_3)_2N/5.HNO_3N/20//KCl.Hg_2Cl_2/Hg$ | Tower | Plated | −1·5042 volt | −1·1156 volt (fresh pasted) |
| | | | | −1·3621 volt (left in air) |
| | | | | −1·5159 volt (plated) |
| $O_2/H_2SO_4 2N//KCl.N/1Hg_2Cl_2/Hg$ .. .. .. | Dolezalek | Plated | −1·893 volt | −1·7145 volt (fresh pasted) |
| | | | | −1·7794 volt (after 2 hours) |
| | | | | −1·7475 volt (fresh pasted) |
| | | | | −1·8203 volt (after 2 days) |

nen acid with hydrocyanic acid, the deposit is the low hydrated oxide contaminated with some of the ick oxide.

10. The single potential of metals and oxides in powder m can be measured accurately by pasting the finely wdered material on a platinum electrode with gelatin.

11. The single potentials of the more stable oxides of anium have been measured.

12. *Uranous oxide* $UO_2$ *gives a single potential identical ith that obtained for the green oxide* $U_3O_8$.

13. Thr black deposit formed when uranium salts are ectrolysed is not $U_3O_8 2H_2O$ as claimed by Smith but it a product having the composition $U_3O_{10}.2H_2O$. Further, does not give the same potential as $U_3O_8$.

14. The position of uranium in the electrochemical ries has not been definitely fixed because of inability to ake pure uranium, but the potential of a sample of ranium containing 91·49 per cent uranium and 8·34 per ent ferric oxide has been measured.

This work was undertaken at the suggestion of Prof. Kahlenberg and carried out under his direction.

## SCIENTIFIC GLASSWARE.

### VOLUMETRIC TESTING AT THE NATIONAL PHYSICAL LABORATORY.

THE manufacture of volumetric scientific glassware—burettes, pipettes, &c.—is an industry which was practically non-existent in the United Kingdom before the war. During the war the industry was largely developed in this country, and it is most desirable that it should remain as a permanent British asset. To attain this end it is supremely important that British-made graduated apparatus should be of reliable accuracy. In establishing a reputation for accuracy British manufacturers realised the advantage of having their apparatus guaranteed by an impartial institution, and all users of such apparatus should know that it is now possible to obtain apparatus whose accuracy has been so verified.

Volumetric glassware has been tested on a small scale at the National Physical Laboratory for the past fifteen years. With the growth of the industry in this country it was felt that the scope of the work should be widened. Consequently, in co-operation with manufacturers and users of scientific glassware, a pamphlet was issued in July, 1918, containing regulations relating to Class A tests, *i.e.*, tests on apparatus required to be of the highest accuracy. A new building has just been completed at the Laboratory specially equipped for dealing with this class of work on a large scale.

At the outset it was urged that in addition to the tests already referred to provision should be made for testing apparatus intended to possess only commercial, or Class B, accuracy. Pending the settlement of a permanent scheme for commercial testing by State, or State-approved institutions, a matter which is now under the consideration of the Government, the National Physical Laboratory is now prepared to undertake Class B tests at the request of manufacturers and others, such tests being carried out for the time being at Teddington. It is hoped eventually to arrange for this work to be done at local centres.

The Class A tests are designed for vessels intended to possess the highest accuracy required for scientific use, but the limits of error assigned for the Class B tests are those with which all graduated apparatus of good commercial quality should comply, and are necessary for the attainment of satisfactory results in ordinary routine analysis. A full account of the tolerances allowed, methods of tests, details of construction, test fees, &c., is given in the new edition of the Laboratory Test Pamphlet relating to "Volumetric Tests on Scientific Glassware," published in November, 1919. Copies of this pamphlet, which was drawn up in co-operation with both manufacturers and users of volumetric apparatus, may be obtained free of charge on application to the Director, The National Physical Laboratory, Teddington, Middlesex.

The attention of users of scientific glassware is particularly directed to the provision made for testing this apparatus, as it is felt that the existing facilities for obtaining standardised volumetric apparatus are not sufficiently widely known. In the event of users of apparatus requiring tests other than those provided for in the pamphlet the Laboratory is always prepared to make special arrangements to meet the particular requirements of any special work.

By making full use of the facilities offered for testing volumetric glassware, users will ensure that they have reliable apparatus without having to make special arrangements to check their own deliveries, and moreover will indirectly tend to maintain a high standard of production throughout the whole industry.

## BOARD OF TRADE ANNOUNCEMENT.

### THE MARKING OF GOODS.

THE Merchandise Marks Committee are completing their arrangements for taking evidence before proceeding to consider their Report. Associations and others who may wish to make representations on any of the matters which the Committee are investigating should communicate with the Secretary of the Committee at the Patent Office, 25, Southampton Buildings, W.C. 2, not later that February 14.

The Committee, who were appointed by the Board of Trade, and sit under the Chairmanship of Mr. Harry Greer, M.P., are dealing in particular with the following questions:—

1. Whether all imported goods, or particular classes of imported goods, should be required to bear on importation, or on sale in this country, a statement as to their origin; whether the statement should specify the actual country of origin, or should merely indicate that the goods are not of British or

not of United Kingdom origin; and whether any such requirement should extend to goods transhipped in this country, or re-exported from this country, to British possessions and foreign countries.

2. The advisability of encouraging the institution of an Empire Mark to denote British origin; the utility and effect of national trade marks and other similar collective marks; and whether any such mark or marks, if used at all, should be administered by the *Government, or by municipalities, or by associations* of traders.
3. Whether any and what international action is necessary or desirable to prevent the false marking of goods with indications of British origin, and to protect regional appellations of origin.

# PROCEEDINGS OF SOCIETIES.

## ROYAL SOCIETY.

*Ordinary Meeting, January 22, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read:—

"*The Stress-strain Properties of Nitro-cellulose and the Law of its Optical Behaviour.*" By Prof. E. G. Coker, F.R.S., and K. C. Chakko.

The physical properties of nitro-cellulose are studied from its behaviour in tension, whereby values of Young's modulus and Poisson's ratio are obtained and the form of the load extension curve determined.

The optical properties of the transparent material are observed, with special reference to its behaviour under load, and it is shown, by observations with a comparison beam not stressed beyond elastic limit, that the relative retardation produced between the two components of a polarised beam is consistent with a linear optical stress law, which holds up to stresses of about twice those at the elastic limit. These observations are confirmed by observations of the retardation bands produced in a polarised spectrum by a beam under uniform bending moment. The stresses and strains are deduced on the assumption of a linear stress-optical law, and stress-strain curve so obtained is found to agree with purely mechanical measurements of a tension number.

"*On Alternating Current Electrolysis.*" By S. Marsh.

The behaviour of platinum, gold, and nickel electrodes, during the passage of alternating current of 25 to 80 cycles per second, has been examined. The electrodes employed were dilute sulphuric acid and barium hydrate solution.

Curves representing relation between volume of gas evolved and time of passage of current are of two distinct types:—

(*a*) One type resembling "saturation current" curves in radio-activity. This effect is shown clearly in the cases of platinum and gold in acid electrolyte.

(*b*) A second type, in which the rate of evolution of gas falls off with time, until ultimately a steady rate of evolution sets in, *decreasing* in value with *increasing* frequency of the alternating current.

Two possible explanations of the phenomena are discussed:—

(*a*) Adsorption of hydrogen at an electrode during one half period, followed by re-combination with oxygen in the succeeding half-period.

(*b*) Oxidation of the electrode by the oxygen of one half-period, followed by reduction of the oxide by the hydrogen of the succeeding half-period.

Evidence is given that the oxidation theory successfully explains the effects with gold and nickel. In the case of platinum it is believed that oxidation plays a prominent *rôle*, though adsorption may also be effective in this case.

It is shown that the electrodes have an initial surface activity in promoting re-combination, which activity increases, (*a*) with frequency of alternation; (*b*) up to a maximum value with the time of passage of the current. If the current density is less than that corresponding to this *maximum activity*, then sooner or later evolution of gas ceases. If the current density is greater, then after a time gas is evolved at a steady rate.

"*The Variations of Wave-length of the Oscillations Generated by Three-electrode Thermionic Tubes due to Changes in Filament Current, Plate Voltage, Grid Voltage, or Coupling.*" By W. H. Eccles and J. H. Vincent.

When electrical oscillations are sustained in a circuit comprising inductance and electrical capacity by aid of a three-electrode thermionic vacuum tube of the kind used in wireless telegraphy, the frequency of the oscillations and the wave-length of the radiation depends principally upon the values of the inductance and the electrical capacity, and partly upon the resistance in the oscillatory circuit; upon the voltages of the various batteries in use; upon the temperature of the filament supplying the electrons; upon other properties of the vacuum tube; and upon the coupling between portions of the circuit associated with the grid and the anode.

The object of the present investigation was to study experimentally the effects of altering each of the chief variables, with a view to finding the conditions most favourable for the production of continuous oscillations of constant frequency. For this purpose two circuits were sustained in oscillations at nearly the same high frequency, namely, 120,000 vibrations per second, and the audible beat between these frequencies was observed. Then changes made in one circuit alone caused variations of frequency that were measurable by acoustic observation of the beat note. The preliminary investigations showed that variation of the heating current of a filament was the most fertile source of erratic changes of frequency, and resulted in the discovery that increase in the filament current of one tube produced at low values of current a decrease of frequency, and at higher values an increase of frequency, while at a certain value of filament current the frequency had a stationary value. This phenomena provides a method of setting an oscillation generator so as to produce a vibration of frequency constant to less than 1 part in 100,000. Provided with this knowledge the other problems enumerated above were attacked.

In an apparatus in which the inductance was 8 millihenries, and the electrical capacity 250 electrostatic units, and wave-length 2750 metres, it was found that raising the voltage of the anode battery from 130 to 140 increased the wave-length by 6 metres, and that raising the grid voltage by 1 increased the wave-length about 10 metres. The coupling in the circuit produced large effects by its variation.

"*Plane Strain. The Direct Determination of Stress.*" By S. D. Carothers.

It is pointed out in the first part of the paper that in plane strain the stresses, if determined directly, are usually obtained by the aid of the well known stress function method. The problem is usually that of finding a function $\chi$ satisfying $\Delta_1{}^4\chi = 0$ throughout the body with suitable values of $\chi$ over the various boundaries. The most general value of $\chi$ in Cartesian co-ordinates appears to be $\chi = A\theta + Bx\theta + Cy.\theta + D\ (x^2+y^2)\theta$ where A, B, C, and D are any constants and $\theta$ is any plane harmonic function.

It is shown that for any orthogonal co-ordinates the stresses derived by the stress function method when applied to $\chi = (x^2+y^2)\theta$ can always be resolved into two distinct sets, while in the case of Cartesian co-ordinates the stresses can be split up into four distinct sets.

iew of the foregoing, the present paper has for its . the determination of the various sets of stresses might legitimately occur in a state of plane strain, ssed in the simplest possible terms, with a view to r the building up of a given state of stress a manage- operation.

e paper sets forth the usual stress equations of brium, and gives the identical relation between the components expressed in the various systems of co- ates. The various possible stress sets in rectangular polar co-ordinates and then set forth in order, after h the solutions in orthogonal curvilinears are obtained ch a manner as generally to show their connection those formerly given.

ie second part of the paper applies the results obtained e solution of some examples.

"An *Investigation of the Effects of Electron Collisions Platinum and with Hydrogen, to ascertain whether Production of Ionisation from Platinum is due to uded Hydrogen.*" By F. HORTON and ANN C. IES.

*The Pressure Distribution on the Head of a Shell ing at High Velocities.*" By L. BAIRSTOW, F.R.S., I. FOWLER, and D. R. HARTREE.

## NOTES.

UR Advertisement columns of January 23 contained advertisement from an "Old Swedish Firm," who were rous of introducing their specialities to English makers Chemicals for the Paper and Pulp Trade, &c. They b to add that they can procure the finest references n English papermakers.

THE dye known as Khaki was discovered by Dr. Haller, o was weaving expert to the Basel Mission in India in forties of the last century.

ROYAL INSTITUTION.—A General Meeting of the mbers of the Royal Institution was held on February 2, James Crichton-Browne, Treasurer and Vice-President, the chair. The special thanks of the members were urned to Mr. A. B. Bence Jones for his present of pies from Scientific Journals of Abstracts of Faraday's iday Evening Discourses used by Dr. Bence Jones in Life and Letters of Faraday. Dr. W. H. Bailey, rs. Champ on de Crespigny, James Campbell Dewar, rs. Dreschfield, G. Bramwell Entenborg, and Dr. W. R arker were elected members.

THE following resolution has been unanimously adopted y the Council of the Institution of Mining and Metal- rgy:—"(1) That the economic conditions now prevailing all for a revision of the pre-war scale of remuneration of lining Engineers and Metallurgists whether they are ngaged in the British Isles or abroad. (2) That members f the Institution of Mining and Metallurgy are entitled o an increase in fees and salaries commensurate with the epreciated value of money and the increased cost of ving. (3) That it is recognised that many Mining Com- anies have already provided at least partially for the ltered conditions, and the Institution confidently relies upon Boards of Directors to meet the new situation in a air and reasonable spirit."

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RE- SEARCH.—The Lord President of the Council has approved the appointment of Colonel Sir Frederic Nathan, K.B.E., late R.A., to be Power Alcohol Investigation Officer under the Fuel Research Board of the Department of Scientific and Industrial Research. The appointment of the Power Alcohol Investigation Officer has been made as a result of the consideration given by the Committee of Council for Scientific and Industrial Research to report of the Interdepartmental Committee on the Production and Utilisation of Alcohol for Power and Traction Purposes, which recommended the establishment of a small perma- nent organisation under the Department of Scientific and Industrial Research to continue investigations into these problems. The Fuel Research Board propose to begin by bringing the work already being done both as regards production and utilisation of alcohol into proper focus. Sir Frederic Nathan, who before the war was Superintendent of the Royal Gunpowder Factory at Waltham Abbey, and later Works Manager of Messrs. Nobel's Explosives Factory, Ardeer, was the officer in con- trol of alcohol under the Ministry of Munitions during the war, and Chairman of the Production Section of the Interdepartmental Committee above referred to. He has been entrusted with the survey of the present position and with making proposals to the Board for such experiment and research as may from time to time appear to be neces- sary. But it is obvious that until a more or less accurate estimate has been made of the possible sources for the production of alcohol within the Empire, and until their probable amount and the cost of using them have been ascertained, it would be useless to embark upon research on any extended scale into methods of production or utilisation. Prof. Pierce Purcell, who was Secretary of the Irish Peat Inquiry Committee, has also been appointed to act as Peat Investigation Officer under the Fuel Re- search Board. The duties of the Peat Investigation Officer will similarly be to keep the Board informed of all progress in connection with research into the utilisation of peat, to continue and extend experiments on the mechani- cal cutting and winning of peat, and to make arrange- ments for careful tests of the use of peat as a fuel under boilers.

TRADE REPRESENTATIVES OVERSEAS.—The following further appointments have been made by the Executive Committee of the Federation of British Industries:—Mr. G. C. Musgrave has been appointed as a representative of the Federation in Cuba. He will be sailing at the end of this month. His address will be communicated to the Press as soon as he has taken suitable offices on his arrival. Mr. Antonio Gibbon, whose address is 7a, Naranja 179 Mexico D.F., has been appointed as a Federation's representative in Mexico. Arrangements for a permanent Secretary in Holland are being made, and details with regard to this will be forwarded as soon as they are complete.

## MEETINGS FOR THE WEEK.

*Monday, February 9.*

Royal Geographical Society, 5.
Biochemical Society, 5.30.

*Tuesday, February 10.*

Royal Institution, 3. "The Evolution of Man and the Early History of Civilisation," by Prof. G. Elliot Smith.
Institution of Civil Engineers, 5.30.
Royal Photographic Society, 7.

*Wednesday, February 11.*

Royal Society of Arts. "Naval Camouflage," by Lieut.-Com. Norman Wilkinson.

*Thursday, February 12.*

Royal Institution, 3. "Recent Progress in Applied Optics," by A. E. Conrady.
Royal, 4.30. "Colloidal Electrolytes—Soap Solutions and their Constitution," by J. W. McBain and C. S. Salmon. "Viscosity of Sulphur," by C. C. Farr and D. B. Macleod. "On Kaufmann's Theory of the Impact of the Pianoforte Hammer," by C. V. Raman and B. Banerji. "Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System," by Commander T. Y. Baker, R.N., and Prof. L. N. G. Filon, F.R.S. "The Lateral

Vibrations of Sharply Pointed Bars," by Prof. J. W. Nicholson. "New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide," by R. E. Slade.

Institution of Electrical Engineers, 6. "Protection of Alternating Current Distribution Systems without the use of Special Conductors," by Major Edgcumbe, R.E.

Optical Society, 7.30.

*Friday, February* 13.

Royal Institution, 9. "The Volume of the Blood and its Significance," by Prof. W. M. Bayliss.

Physical Society, 5.

*Saturday, February* 14.

Royal Institution, 3. "The Astronomical Evidence bearing on Einstein's Theory of Gravitation," by Sir F. W. Dyson.


## SCIENTIFIC BOOKS AND SERIALS.

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*Fuller particulars of the above, together with Tender Forms and* permits to view, can be obtained on application to the CONTROLLER, D B. 1 E., Embankment Buildings, Charing Cross, W.C. 2.

**NOTE.—For particulars of other Government Property for sale see "SURPLUS," price 3d. at all bookstalls, or by quarterly subscription of 2/- post free, payable in advance to the Director of Publicity, Ministry of Munitions Whitehall Place, London, S.W 1.**

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# WHOLE-NUMBER ISOTOPES AND ALLIED PHENOMENA.

By F. H. LORING.

### *Experimental Demonstration of Isotopes.*

DR. F. W. ASTON, in *Nature* of Dec. 18, 1919, records new experiments with his improved *positive-ray spectrograph*,* which should be of interest to the readers of the CHEMICAL NEWS. Aston says:—"*A fact of the greatest theoretical interest appears to underlie these results, namely, that of more than forty different values of atomic and molecular mass so far measured, all, without a single exception, fall on whole numbers*, . . . due allowance being made for multiple charges." The italics are mine.

2. The results given are as follows:—

Carbon—No isotopes; at. wt. 12 exactly.
Oxygen—No isotopes; at. wt. 16 exactly.
Neon—Two isotopes; at. wts. 20 and 22.
Chlorine—Two isotopes; at. wts. 35 and 37.
Mercury has isotopes round 200, but accurate values cannot yet be given.
Hydrogen has not yet been measured.

3. These complexities have to be considered, and, moreover, since the Prout hypothesis is practically proved, Rutherford's outrider of nitrogen (see CHEMICAL NEWS, 1919, cxviii., p. 311) of mass 2 ($H_2$ possibly) leads to the suggestion that, for example, chlorine may carry in the case of one of its isotopic atoms a similar outrider. I discussed in this journal (1909, xcix., p. 148) the question of atomic satellites, and I suggested that nitrogen was complex, and indicated that it did not fit into a mathematical scheme shown, but further confirmatory evidence is necessary before the idea of *outriders* can be definitely accepted.

### *Spectroscopic Examination of Isotopes.*†

1. The spectroscopic findings of T. R. Merton (Royal Society Meeting, Dec. 4, 1919) are of considerable interest. Interferometer measurements of the principal line in the spectrum of ordinary lead and lead from pitchblende (uranium lead), and similarly from Ceylon thorite, thallium found in pitchblende residues, and ordinary thallium, give results as follows:—

Uranium lead—Less refrangible than ordinary lead by 0·0050 A ± 0·0007 A.
*Ceylon thorite lead—More refrangible than ordinary lead* by 0·0022 A ± 0·0008 A.
Thallium from pitchblende—More refrangible than ordinary thallium by 0·0055 A ± 0·0010 A.

2. The author states that, unless disturbing factors affect the results, it would appear that thallium in pitchblende is an isotope of ordinary thallium.

3. In considering this aspect of the question, it is of possible interest to note that the elements of a Mendeleeff group exhibit spectroscopic differences on a large scale, whereas the isotopes exhibit differences on such a scale as barely to be measurable. In this connection see CHEMICAL NEWS, 1919, cxviii., p. 145, Section 24; see also Section 7 below.

### *Photo-Electric Effect and Isotopes.*

1. There is another line of attack that may be of theoretical interest. In the CHEMICAL NEWS (1919, cxix., p. 199), in discussing the theory of conduction in metals, I suggested that the general isotopic theory might be of possible interest in connection with the photo-electric effect. (This effect,* stated simply, is the emission of negative electrons from metal surfaces when illuminated with ultra-violet light; but the *emission is not strictly* limited to metals, as arsenic, for example, gives off electrons, and some effect is noticed with gases, vapours, and water, but in the case of gases and vapours, ionisa*tion is most evident with other agents, such as X-rays*; yet "there need not be a fundamental distinction on this account"—Hughes); for, if the electrons are in orbital movement, then at the surface of the metal there are open or exposed orbits, and *if light* of short wave-length is capable of expanding these orbits (those favourably disposed), just as heat waves are absorbed and expand metal in bulk, the electrons should fly out of the metal very much as molecules leave a liquid on evaporation. Postulating (I am here *quoting from my previous paper*) atoms of different mass (whole-number isotopes), ununited chemically in the orthodox sense, and all mixed up together, means that there should be instability in the electronic orbits, and *it is this instability that might give rise to easy conduction and other effects requiring a small starting force to give* rise to certain phenomena. It must be remembered that at exceedingly low temperatures, verging on the absolute zero, large currents can easily be induced in closed-circuit *conductors, which currents continue to flow for a time of* their own accord.

2. In considering the characteristics of the photo-electric effect, it has been found that whilst the number of electrons leaving a surface is proportional to the intensity of the light, the intensity of the effect, *i.e.*, the velocity with which the electrons are emitted, is not dependent upon the light intensity, since, by increasing the distance between the light-source and the substance receiving the *light, the intensity of the effect is not diminished. It is to* be noted that the term *intensity* is used in two different senses. The velocity with which the electrons are supposed to leave the surface is between $10^7$ and $10^8$ cms. per second. In some cases of compounds, salts, for example, the effect when it does occur may arise from the surface decomposition of the substance itself by action of the light, so that the atoms or molecules are less bound together by electronic or chemical ties, and, indeed, *in this circumstance the electrons are in a freer state to* be influenced by the light, and hence emission takes place. This explanation pre-supposes *two* actions, whereas, in reality circumstantial variations in the one general phenomenon are probably involved. It is precisely this form of reasoning that sometimes introduces unnecessary complication or duplication of theory in scientific matters. In this connection see W. C. M. Lewis, *Journ. Chem. Soc.*, 1914, cv., p. 2330; 1915, cvii., p. 233; 1916, cix., pp. 55, 67 (see Kruger, *Zeit. Elektrochem.*, 1911, xvii., p. 453), and 796; 1917, cxi., pp 389, 457, and 1086; 1918, cxiii., p. 471; 1919, cxv., p. 182. *Phil. Mag.*, 1920, xxxix., p. 26 (Q). *Brit. Asso. Rept.*, 1915, p. 394. M. Trautz, *Zeit. Anorg. Allgem. Chem.*, 1918, pp. 81 to 129. U. Pratolongo, *Gazz. Chim. Ital.*, 1918, xlviii., pp. 121 to 193. Marcelin, *Comptes Rendus*, 1914, clviii., p. 116. J. Perrin, *Ann. Phys.*, 1919, xi., pp. 5 to 108—or a full abstract (about 1300 words) *Abstracts, Am. Chem. Soc.*, 1919. R. Thomas, *Journ. Chem. Soc. Ind.*, 1920, xxxix., pp. 10 T to 18 T. All the above references (see also Loring, CHEMICAL NEWS, 1919, cxviii., p. 145, Sec. 32) refer to chemical activation or combination or dissociation induced by radiation, and the paper marked (Q) refers to

* *Phil. Mag.*, Dec., 1919.

† See in this connection—T. R. Merton, *Roy. Soc. Proc.*, 1915, xci., p. 198; or *Sci. Abs.*, 1915, A, p. 228. J. R. Cotter and F. Soddy, *Nature*, Jan. 30 and Feb. 6, 1919. W. Duane and T. Shimizu, *Nat. Acad. Sci. Proc.*, June, 1919. L. Aronberg, *Astrophys. Journ.*, 1918, xlvii., p. 96.

* Sometimes called the Hallwachs effect, as Hallwachs was one of the first to investigate this phenomenon. It will be remembered that Hertz, when conducting his epoch-making experiments on electromagnetic waves, noticed that when a spark-gap was illuminated with ultra-violet light a discharge *took place more freely*.

the application of the quantum theory to chemical reactions. In the paper by Thomas, "On the Addition of Hydrogen to Unsaturated Glycerides in the Presence of Nickel," it is suggested that the molecules of olein are *brought into active condition by absorption of infra-red* radiation emitted by the catalyst—a conception first put forward by Lewis and Lamble for the hydrolysis of methyl acetate in a homogeneous system, the catalyst being the **hydrogen ion.**

3. In view of the foregoing statements, the corpuscular theory of light, including X-rays and $\gamma$-rays (these rays are now proved to be light of exceedingly short wave-length—in fact, they are of atomic dimensions), would seem to fully explain this emission phenomenon; but the electromagnetic-wave theory of light is so firmly established by interference and dispersion phenomena that this explanation *is extremely doubtful. See also the classical experimental* work of Hertz on electromagnetic waves.

4. It has been suggested, however, that the high-frequency light acts like a trigger in releasing electrons from their sphere of activity; but the advent of Einstein's *equation, given below*, and *Bohr's equation for the* hydrogen atom, both of which harmonise with each other, fitting in with the energy factors concerned in the photo-electric effect, and, moreover, the difficulty of finding an electro-atomic mechanism to give rise to the *trigger action*, has been the *means of relegating* this release theory to the background.

5. One phase of Bohr's theory involves the idea of electronic orbits being at least theoretically expansible in the case of hydrogen (there is evidence of this behaviour of hydrogen), whereby the atomic sizes should occur in jumps 4, 9, 16, 25 . . . (or 1, 4, 9, 16, 25 . . "normal" hydrogen being 1), the formulæ involving the energy quantum idea of Planck (for a brief simplified statement of Bohr's theory see CHEMICAL NEWS, 1919, cxviii., p. 145, Section 12), the energy being done up, as it were, in indivisible bundles. It is to be noted that *the photo-electric effect is roughly the converse of* emissive phenomenon involving monochromatic radiation (see Jeans' "Dynamical Theory of Gases," Chap. XVIII.). This treatment fits in with Einstein's equation, apparently involving energy quanta when considering the photo-electric effect, the equation being—

$$\tfrac{1}{2}mv^2 = k\nu - \omega_0.$$

$m$ = mass of the electron.
$v$ = max. velocity of electrons for light of frequency $\nu$.
$k$ *and* $\omega_0$ = *constants for the metal.*
$\nu_0$ = the frequency below which no emission takes place.

$$\nu_0 = \omega_0/k.$$

In the case of sodium, for example, $\nu_0 = 5{\cdot}15 \times 10^{14}$ (green light). "Light more red than this can fall on sodium for centuries without producing any photo-electric effect at all; the incidence of light *more violet* than this will immediately result in an emission of electrons with a maximum kinetic energy $k(\nu - \nu_0)$."—Jeans' "Report on the Quantum Theory," 1914, p. 59.

In the above equation $\omega_0$ may be the energy required just to expel the electron from its atom. The work needed to effect this removal and then give the electron a velocity $v$ is—

$$\tfrac{1}{2}mv^2 + \omega_0,$$

and this is equal to $k\nu$. From Table I. prepared from Jeans' report, the average value of $k$ is $5{\cdot}5 \times 10^{-27}$, while Planck's constant $h$ is by the latest evaluation (R. T. Birge, *Phys. Rev.*, 1919, xiv., p. 361) $(5{\cdot}5543 \pm 0{\cdot}0025) \times 10^{-27}$ *erg. sec. Thus, according to* this argument, the amount of energy $k\nu$ absorbed by the electron in freeing itself from the atom is nearly equal to Planck's quantum apart from the frequency of the incident light (see Sections 13 and 14 below). It therefore seems *necessary that the light energy of frequency* $\nu$ *should* exist in indivisible bundles of amount $h\nu$; and on this view it is possible to explain why the light frequency less than the critical frequency $\nu_0 = \omega_0/k$ cannot produce any emission of electrons. It cannot be denied, however, that Einstein's conception of the energy quantum is beset with serious difficulties. I have drawn freely from Jeans' report in the *above statement.*

TABLE I.

| Element. | At. wt. | $V_0$. | $k$. | $\lambda_0$. |
|---|---|---|---|---|
| Calcium .. .. | 40·1 | 2·57 | $4{\cdot}91 \times 10^{-27}$ | 3700 |
| Magnesium .. | 24·3 | 3·08 | 5·24 | 3300 |
| Cadmium .. | 112·4 | 3·49 | 5·67 | 3140 |
| Zinc.. .. .. | 65·4 | 3·77 | 5·88 | 3016 |
| Lead .. .. | 207·2 | 3·42 | 5·50 | 3115 |
| Bismuth .. .. | 208·0 | 3·37 | 5·63 | 3233 |
| Antimony .. | 120·2 | 3·60 | 5·72 | 3075 |
| Arsenic .. .. | 75·0 | 4·5 | 5·7 | 2360 |
| Selenium.. .. | 79·2 | 4·8 | — | 2200 |
| Oxygen .. .. | 16·0 | 8·0 | — | 1350 |

I have added $\lambda_0$, which is the wave-length at which the effect sets in. $V_0$ above is the potential difference through which an electron would have to fall to acquire kinetic energy $\omega_0$, so that $eV_0 = \omega_0$. Hughes finds $V_0 = 8{\cdot}0$ volts for $O_2$, while the best direct determination of the ionisation potential gives 8·1 volts. Jeans says that the above values are good experimental determinations, being those of Hughes. See "Photo-Electricity," by A. Ll. Hughes.

6. It will be necessary to consider a few other aspects of the subject. The alkali metals exhibit two distinct *effects—the normal* and the *selective. The selective effect* is that part of the total effect that appears when the light becomes polarised, and then occurs over a limited range of wave-lengths. The normal effect increases with the decreasing wave-length, and it does not depend upon the *polarisation of the light except in so far as it affects the* normal light absorbed. All metals exhibit the normal effect.

7. The selective *maximum* effect shifts towards the red end of the spectrum in passing from lithium to cæsium, and *the convergence frequency of the principal spectral* series for the alkali metals shows a similar shift.

8. Probably the normal and selective effects are circumstantial variations of the same general phenomenon. *In both cases the velocities of the emitted electrons are of the same order.*

9. The electrical conductivity of silver iodide *increases when* exposed to light from an arc lamp. The photo-electric effect occurs only when this salt is illuminated with ultra-violet light.

10. Dr. Hughes states (*loc. cit.*, p. 125) "that substances dissolved in hexane were tested and the volume ionisation measured. The results are given in Table II., together with Stark's relative values for the photo-electric effect of the solid substances." The author remarks:—

TABLE II.

| Substance. | *Conductivity* of solution. | *Relative photo-elec.* effect for solute. |
|---|---|---|
| Napthalene .. .. .. .. | 0 | 1·2 |
| Phenol .. .. .. .. .. | 0 | 2·2 |
| Phenanthrene . .. .. | 6 | 8·2 |
| Diphenylmethane .. .. | 7 | 17·0 |
| $\beta$ Phenol . .. .. .. | 10 | 10·6 |
| Anthracene .. .. .. | 20 | 12·5 |
| a-Napthylamine .. .. | 40 | 15·0 |
| Diphenylamine .. .. | 50 | 17·0 |

"It is clear that the increased volume conductivity of a *solution is very closely connected with the photo-electric* effect of the corresponding solute. This was checked by using absorption screens for the light." The two effects for anthracene, solid and in solution, show corresponding agreement.

11. *Passing to another consideration, the constancy of* the effect irrespective of temperature, at least between $-180^\circ$ C. and $800^\circ$ C. for gold, platinum, and iridium,

seems to show that *it is dependent upon conditions that do not alter with temperature.* It must be remembered that a surface effect is involved in this case.

12. Assuming now that the electronic orbits are expansible as in Bohr's theory and that the orbits, under certain circumstances, particularly in metals, are unstable, as pointed out in Section 1 above, then the effect can be treated in a modified way, which, with regard to experimental facts, appears to be consistent in many respects. Consider, by way of example, a bicycle inner-tyre tube being inflated without the usual cover, but containing initially some air under pressure, the extra compressed-air energy delivered to the tube corresponding with the ultra-violet light, the air flowing steadily into the tube which represents the orbital system. When the elastic limit of the rubber is reached the tube will suddenly expand to large dimensions, but just before expansion the tube would contain one quantum of energy, and in the event of the tube bursting this action would represent the photo-electric effect. Moreover, should such a tube have, say, three elastic limits then three quanta of energy would be emitted spasmodically, yet the delivery or absorption of this energy would be continuous, whilst the emissions would be such as to give rise to waves in the surrounding air that would occur in jumps or quanta, but contraction may be involved in the case of monochromatic radiation as distinct from the photo-electric effect (see Sec. 4 above). This hypothetical analogy leads therefore to the constant *h* being of the nature of an elastic-limit function peculiar to the tyre but modified by the air-pressure extraneous to it. The analogy at this point suggests that the air-pressure on the outside of the tube represents the hypothetical aether under strain, and then the properties of the electron become involved with the aether; but whether the properties of the electron can be wholly or partially transferred to the aether is a matter which has been under consideration and physicists hold different views in this respect. Going back to Maxwell's classical equations, based on Faraday's experiments, the part played by the medium surrounding a current-bearing wire was all-important, or in Dolbear's phraseology physical fields of force are a part of all ultimate physical phenomena. (See latter part of Section 2 above, and Chem. News, 1917, cxv., p. 181). Returning to the tyre analogy, there are surface conditions or mutual influences which no doubt modify the photo-electric effect as regards solid substances, in particular metals. The effect sets in at a certain light frequency for a given metal, and when considering the special "selective" effect of the alkali metals, or generally the variations in the phenomenon, it is not inconsistent to consider the tyre particularly susceptible to energy in a form it can readily absorb, as instanced by ultra-violet light.

Planck assumed later that the resonators (the hypothesis of resonators need not be discussed here) emit their light radiation in complete quanta (spasmodically) and that they absorb the energy in a continuous manner. Jeans says (Report, p. 84) "Absolutely instantaneous emission is not in any way required, but the emission must be catastrophic in the sense that when once it has started nothing can stop it until a whole quantum has been set free." There appears to be about five factors of importance, which are—The electronic orbits, their relation to each other, the aether if it exists, and the mass magnitudes of the atoms themselves, and possibly their relations to each other, and of course the incident light when considering the photo-electric effect.

13. Prof. Millikan ("The Electron," p. 236) says:—"The appearance of *h* in connection with the absorption and emission of *monochromatic* light (photo-electric effect and Bohr atom) seems to demand some hitherto unknown type of absorbing and emitting mechanism within the atom. This demand is strikingly emphasised by the remarkable absorbing property of matter for X-rays, discovered by Barkla (*Phil. Mag.*, xvii., p. 749), and beautifully exhibited in De Broglie's photographs opposite p. 97. It will be seen from these photographs that *the atoms of each particular substance transmit the general X ray up to a certain critical frequency and then absorb all radiations of higher frequency than this critical value.* The extraordinary significance of this discovery lies in the fact that it indicates that there is a type of absorption which is not due either to resonance or to free electrons. But these are the only types of absorption which are recognised in the structure of modern optics. We have as yet no way of conceiving this new type of absorption in terms of a mechanical model. There is one result, however, which seems to be definitely established by all of this experimental work. Whether the radiation is produced by the stopping of a free electron, as in Duane and Hunt's experiments, and presumably also in black-body experiments, or by the absorption and re-emission of energy by bound electrons, as in the photo-electric and spectroscopic work, Planck's *h* seems to be always tied up in some way with the emission and absorption of energy by the electron. *h may therefore be considered as one of the properties of the electron.*" The italics are the author's. (See Section 12).

14. It is of further interest to note that Millikan (*Proc. Nat. Acad.*, April, 1917) re-determined the value of *e*, the fundamental unit negative charge of the electron, or atomic unit of negative electricity, with an estimated accuracy of 1 part in 1000, obtaining the value $4 \cdot 774 \times 10^{-10}$ E.S.U., and he also determined (see *Phys. Rev.*, 1916, vii., p. 362) *h photo electrically*, with an error, in the case of sodium, of not more than one-half of 1 per cent, the value being $6 \cdot 56 \times 10^{-27}$.

15. The theory of electronic orbits is pretty well established, but there are conditions and variations which make it necessary to be very careful in the use of terminology in this connection. Apart from an electron (= negative, unless otherwise stated) in "vibration":—

An electron may exist free, as when expelled from th atom.

An electron may be so firmly bound as to exhibit no properties involving extreme mobility.

An electron may be free enough to pass from one orbital state to another, or,

An electron may be so influenced as to have its orbi expanded or contracted.

An electron may describe an ellipse, or move progressively so as to trace a series of figure eights, or take on an undulatory movement. There may be other theoretical modifications in the electronic states in matter.

16. Returning now to the photo-electric effect, this action appears to be connected with the isotopic atoms (see Section 1), as the percentage of higher atomic mass isotopes (see Chemical News, 1919, cxix., pp. 14, 62, 199, and 280) divided into the respective atomic weights (mean mass values) gives values inversely related to the $V_0$ values of Hughes—see Tables I. and III.—as when these elements, those which I have already studied, are arranged in the periodic-table order (this journal, p. 62) and the values of Column 1 below are plotted with those of Column 3 below, the latter in an inverse-magnitude order by dividing 10 (say) by the values, the two curves have the same characteristics so far as can be judged.

In plotting the values, the points may be joined by straight lines, when it will be found that *all the angles between corresponding pairs of points, as formed by the lines, are identical within probable experimental error.*

Table III.

| Element. | $V_0$. | Percentage of higher atomic mass isotopes. | Atomic weight / Per cent of higher at. mass isotopes. |
|---|---|---|---|
| Selenium | 4·8 | 84·7 | 0·93 |
| Arsenic | 4·5 | 75·0 | 1·00 |
| Zinc | 3·77 | 33·3 | 1·96 |
| Antimony | 3·60 | 58·9 | 2·04 |
| Cadmium | 3·49 | 36·3 | 3·09 |
| Bismuth | 3·37 | 50·0 | 4·16 |
| Lead | 3·42 | 47·3 | 4·38 |

Although it was considered that, from theoretical considerations, some such relationship as just described *should follow, it is perhaps best to avoid too much* elaboration pending the confirmation of some of the values made use of in this study. It seems hardly prob*able that these relations are accidental, yet that possibility* has to be considered; indeed, one is sceptical as to the final outcome of modern speculative philosophy; but *there is one certain fact, that the views given above are* near to some truth when taking into consideration the confirmed experimental facts that stand out as landmarks, though the inter-connected details are obscure. The subject is undoubtedly of great interest and certainly in one respect support is given to the theory of whole-number isotopes.

17. The following literature on the photo-electric effect and allied subjects should be studied :—

J. H. Jeans, "Dynamical Theory of Gases," 1916, Cambridge University Press.
J. H. Jeans, "Rept. on Radiation and Quantum Theory," Electrician Printing and Publishing Co., London.
A. Ll. Hughes, "Photo-Electricity," Cambridge Univ. Press.
N. R. Campbell, "Modern Electrical Theory," Cambridge Univ. Press (2nd edition).
O. W. Richardson, "Electron Theory of Matter," Cambridge Univ. Press (2nd edition).
O. W. Richardson, "Emission of Electricity from Hot Bodies," Longmans, Green, and Co.
H. S. Allen, "Photo-Electricity," Longmans, Green, and Co.
R. A. Millikan, "The Electron," University of Chicago Press.
R. W. Wood, "Physical Optics," Macmillan Company

*Cyclic Evolution of the Elements and Isotopes.*

Sir William Crookes indulged in a speculation on the evolution of the elements which I elaborated in this *journal* (1915, cxi., p. 157) as the introduction of whole-number isotopes in the Periodic Table called for some form of cyclic evolution. The type of table used, however, was one similar to the two-part table shown in my "Studies in Valency," p. 23. In this connection see Chemical News, 1912, cvi., 37. The essential feature of the cyclic scheme is shown in the following Fig. reproduced from the 1915 paper cited above.

Recent experimental data give support to some such scheme as here shown. In the first place, it will be seen that the two end-elements *of one of the loops, neon* and chlorine, have dual isotopes as indicated in the first part of this paper. In the second place, the 1919-20 *Report of the International Committee on Atomic Weights* (Chemical News, 1920, cxx., p. 40) confirms the almost negligible fractional values of the elements that constitute *that part of the cycle where there is no doubling back of* the loop, these elements being :—

| | | |
|---|---|---|
| Carbon | .. .. | 12·004 to 12·006 |
| Nitrogen | .. .. | 14·008 |
| Oxygen | .. .. | 16·000 (standard) |
| Fluorine | .. .. | 19·002 to 19·008 |

and in addition—

| | | |
|---|---|---|
| *Hydrogen* | .. .. | *1·00767 to 1·0078* |

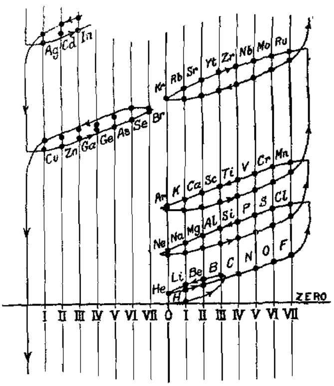
*$H_3$*, J. J. Thomson's *polymeride of H, or a pseudo-element.*

| | | |
|---|---|---|
| Helium | .. .. | 3·998 or 4·000 |

Further, to the general confirmation that all the above *elements are practically pure whole-number elements, and* without atoms of appreciable difference in atomic weight (helium might be slightly isotopic according to its place in the *above figure, in which case the values, for example,* might be 4·004 and 3·996), those elements that *should* be isotopic in the early part of the cycle have values involving fractions of some magnitude, namely :—

| | | |
|---|---|---|
| Lithium | .. .. | 6·94 |
| Beryllium | .. | 9·1 |
| Boron | .. .. | 10·896 to 10·905 |

Referring to the Fig. it should be noted that the loops *were not drawn to any established scale, as no isotopic* values were known at the time the drawing was made, except that neon had probable values of 20 and 22. Another *point to be noted is that should the loop-scheme involve time*, as is presumably the case, no lines can be absolutely vertical unless jumps occur involving inappreciable time. *Time being an unknown factor*, some parts were drawn vertical for convenience. This convention was allowable




as the whole scheme at the time published was speculative and still *remains so, yet there is an element of truth if the* coincidences can be interpreted in the manner indicated.

*Evaluation of Hypothetical Isotopes.*

In developing this paper and the others published in this journal during 1919 I have made use of isotopic proportions worked out in 1914-15. It will be conducive to clearness to give a condensed table of these values which will show the numerical scheme involved, but it must not be expected that even should the ideas be near to the truth the precise values I have worked out will be confirmed. There are so many failures in coincidental relations that one must always be sceptical yet recognise what may be the truth, since it often happens that faulty theories lead to advances in pure and applied science (see Table IV.).

All the values (*a* and *b*) are those I worked out in 1914-15, except the proportionate numbers for In, Sn, Tl, and Pb.

The atomic weight of ordinary lead is of interest in fixing the proportionate numbers, but it is difficult to construct a value that agrees with the following mean; a complexity evidently exists that may be cleared up by the positive-ray method of analysis, provided a suitable volatile lead compound can be obtained and used.

| | | |
|---|---|---|
| Richards and Wadsworth (1916) | .. .. | 207·183 |
| Richards and Hall (1917) | .. .. .. | 207·187 |
| Baxter and Grover (1915) | .. .. .. | 207·20 |
| Average value | .. .. . | 207·190 |

Investigations of radio-active phenomena have revealed the fact that cases arise in which two radio-atoms may

e same mass yet differ in chemical properties; and, er, in other cases, radio-atoms are found to differ ; by several units yet have like chemical properties. parent inconsistencies in the above table are thereby :d now that the principle of isotopy is found to .o the atoms of ordinary elements.

TABLE IV.

| u. | Zn. | Ga. | Ge. | As. | Se. | Br. |
|---|---|---|---|---|---|---|
| ×7 | 64×6 | 68×5 | 71×4 | 72×3 | 75×2 | 79×1 |
| ×1 | 68×3 | 72×5 | 73×7 | 76×9 | 80×11 | 80×13 |
| 500 | 65·333 | 70·000 | 72·272 | 75·000 | 79·230 | 79 928 |
| ·57 | 65·37- | 70·1 | 72·5 | 74·96 | 79·2 | 79·924 |
| ·5 | 33·3 | 50·0 | 63 6 | 75·0 | 84·7 | 92·8 |

| lg. | Cd. | In. | Sn. | Sb. | Te. | I. |
|---|---|---|---|---|---|---|
| 7×7 | 111×7 | –×7 | –×7 | 119×7 | — | 126×1 |
| 1×2 | 115×4 | –×6 | –×8 | 121×10 | — | 127×12 |
| 7 888 | 112·454 | — | — | 120·176 | — | 126 923 |
| 7·88 | 112·40 | 114·8 | 118·70 | 120·2 | 127·5 | 126·92 |
| :2·2 | 36·3 | 46·2 | 53·3 | 58 9 | — | 92·4 |

| Au. | Hg. | Tl. | Pb. | Bi. |
|---|---|---|---|---|
| )6×7 | 199×8 | –×9 | –×10 | –×11 |
| )0×3 | 203×5 | –×7 | –×9 | –×11 |
| )7·200 | 200·538 | — | — | 208·000 |
| :97·2 | 200 6 | 204 0 | 207·20 | 208·0 |
| 30·0 | 38·5 | 43 7 | 47·3 | 50·0 |

= Lower-mass isotopes and proportionate number.
= Higher-mass isotopes and proportionate number.
= Mean atomic weight.
= Experimental atomic weight taken from the 1919-20 Table (*loc. cit.*).
= Percentage of higher mass isotopes by proportionate numbers.

*Isotopes and Electrical Conductivity.*

'or a discussion of the possible relation between the opic properties of the elements and their electrical ductivities see CHEMICAL NEWS, 1919, pp. 14, 62, 199, l 281. (Correction: on p. 64, 4th para. from top," one ole-number" should read *unity*).

*General Observations.*

t will be seen that there is an accumulation of evidence .t whole-number isotopes are a reality, and, moreover, .t the isotopic proportions may modify the electrical perties of the elements.

The following from *Nature*, Dec. 18, 1919, is of erest:—

"A dozen years ago the expressions 'newer physics' d 'newer chemistry' would have been taken to refer to ose branches of the subjects which centred round the ords 'electron' and 'radium' as opposed to those aling with surface tension, sound," &c., or with atomic eights and constitutional formulæ to which the term older' might have been applied. It is interesting to ote how the last few years have rendered the two terms appropriate, and how fields which were considered orked out, or at least not likely to produce returns which ould justify the time spent on further research, have roved themselves not merely fertile, but also worthy of ultivation for many years to come. A revision of stronomy and physics in the light of the theory of elativity has to be carried out; the hydrophone has rought new problems in elasticity to light; we want more nowledge of atomic weights, of the action of catalysts, nd of the synthesis of nitrates. On surface tension and ontact angles a whole industry has been founded, some f the problems of which are dealt with by Mr. H. L. ulman in a paper read before the Institution of Mining nd Metallurgy on 'Flotation,' a summary of which ppears elsewhere in this issue." (See CHEMICAL NEWS, 1919, cxix., p. 278).

## GLASS AND SOME OF ITS PROBLEMS.*

By Sir HERBERT JACKSON. K.B.E., F.R.S.

(Concluded from p. 66).

IN this lecture it will only be possible to deal more or less briefly with opal and coloured glasses. Many vitreous bodies which crystallise fairly readily when heated can be seen to pass through a stage in which the material segregating from them appears first as an opalescence, increasing in density as the heating is continued, and finally passing into a visibly crystalline form. A glass approximating in composition to $Na_2O.CaO.8SiO_2$ shows this opalescence well before small crystalline nodules appear similar to those in the tank glass referred to earlier. Various silicates and borates of calcium, barium, and magnesium show the some kind of phenomenon more readily, and by quickly cooling when a stage of dense opal appearance is reached, sections (or, what is just as good for the purpose, the finely ground glassy material mounted in Canada balsam) can be examined under the microscope and the opal effect shown to be due to the scattering of light by numerous small transparent globules. Any glass from which, on cooling, part of it segregates out in very small particles evenly diffused through the mass, may be called an opal glass whether the fine particles are crystalline or amorphous, but the usual opals owe their milkiness to globules, in which no evidence at least of the crystalline state can be found. Under the microscope the globules, if sufficiently visible as distinct particles, appear vitreous and transparent, just as in milk the fat globules are seen to be themselves colourless and transparent. Among the many substances which can be used to produce opal glasses, the most common are fluorides such as calcium fluoride, cryolite the double fluoride of sodium and aluminium, and calcium or sodium phosphate, less commonly the arsenates of these metals. These substances can be included in the batch mixtures of ordinary soda or potash lime glasses, or lead glasses, or zinc glasses. In the making, opal glasses are usually clear at a high temperature and "strike" opal on cooling. To what extent the glass has to be cooled before becoming opal depends on the concentration of the particular opal-producing compound which is held in solution in the very hot glass. Opal glasses produced with phosphates "strike" generally speaking at higher temperatures than those made with fluorides, the compounds formed in the glass by the latter being more soluble than those due to phosphates, at least in the case of most opal glasses made on a commercial scale. Whatever opal-forming material is potential in the molten glass, if its concentration be great, the glass "strikes" opal quickly and with relatively little cooling and becomes a denser opal as cooling proceeds, until the stage is reached when no more material segregates. Just, however, as in the crystallisation of an ingredient in a glass, cooling may occur so quickly that a state of viscosity is reached in which crystallisation cannot proceed, so with opal glasses the concentration of the opal-producing material may be such that only a little of it comes out of solution before the viscosity of the glass gets too great to allow of further separation. With still less concentration, moderate-sized pieces of the glass may even solidify in a perfectly clear condition, but again, just as re-heating will often cause a glass which has cooled vitreous to become more or less crystalline, so re-heating the intended opal glass will cause it to "strike." This can be illustrated by blowing a bulb from a tube of an opal glass. If the bulb be not too thick, and the concentration of the opal-forming material be not too great, the glass will go quite clear in the flame and the blown bulb will remain quite clear on cooling. If the bulb be then again heated gradually in a flame, the whole process from a mere trace of opalescence to a very dense opal can be watched. If

* The Trueman Wood Lecture delivered at the Royal Society of Arts, April 30, 1919. Owing to extreme pressure of work, Sir Herbert Jackson has only recently been able to complete the M.S. of his lecture. This accounts for the delay in its publication.

puring the various stages of opacity the light transmitted through the glass be observed, it will be seen to change from light orange yellow to darker and darker orange and orange red, until no more evidence of colour is seen, but only a general translucence. If thin sections (or ground-up pieces mounted in Canada balsam) of the opal glass in the various stages be examined under the microscope no separate particles in the earlier stages will be seen, even with lenses of large angular aperture, though their existence can be inferred from the opalescence which is to be well seen under the microscope with suitable black ground illumination. In the later stages of denser opal, separate particles are visible, and are seen to be progressively larger as the density of the opal is greater and greater.

When an opal glass is required for articles, the making of which involves working the glass in a muffle or in the flame, it is important that the separated globules shall not tend to aggregate or to pass into the crystalline state, otherwise the glass is found to have a rough surface. To guard against this, too great concentration of the opal-forming material must be avoided, and some workers prefer a glass which does not reach its full opal until it has been in the annealing oven. As a general experience with a wide range of all kinds of opals, it would appear that fluoride opals are more kindly in working than phosphate opals. This is more especially true for the denser kinds of opal. For merely opalescent glasses, phosphates give quite good results, but with greater concentration of the opal forming substance there is a tendency towards crystallisation, which is more marked as a rule in the phosphate than in the fluoride opals. A dense opal suitable for working in a flame should "strike" opal even in thin pieces on removal from the flame, and should stand long-continued heating without losing its fine polished surface. When such a glass while opal is drawn out into a rod and longitudinal sections of the rod are examined under the microscope, the globules are to be seen egg-shaped or even elongated into minute rods. If an end of the opal rod be heated again to softening point and sections of that end be examined, the opal-forming material is seen to have gone back to spheres, showing that even when separated out the opal material has about the same softening point as the rest of the glass. It is easily to be understood that if it has not, and the globules are of appreciable size, a glass containing them cannot be worked without roughening. One more point may be mentioned before concluding this short general account of opals. A glass may be required which, while remaining clear in thin pieces after removal from the flame, will "strike" on re-heating so readily that the temperature needed to develop the full density of the opal is not high enough appreciably to soften the glass and so cause deformation. One way of securing this behaviour is to add as an ingredient a small amount of a substance which will produce a trace of a compound in-soluble in the glass except at very high temperatures. In the flame this compound persists as a slight turbidity and appears to facilitate the "striking" by affording nuclei on which the opal material can collect.

Coloured glasses are sometimes divided into two main groups—(a) Those in which the colouring matter is diffused in very small particles throughout the glass, and which may be likened to colloidal solutions; and (b) those in which the colouring substances are in a state resembling that of solution, and which may be likened more nearly to aqueous solutions of coloured salts. Just, however, as in aqueous solutions there may be traced or inferred all grades of subdivision of the colouring matter from separate particles which can be revealed by their scattering action on light, and which may be seen in the ultra microscope, through smaller and smaller particles scattering light less and less obviously down to those in the extreme state of subdivision frequently described as that of true solution, so in glasses similar grades of subdivision of their colouring matter may be seen or inferred.

It is, in fact, impossible sharply to divide coloured glasses into these two groups; but it can be said of certain glasses that they are typical of group (a), and among the more common of these may be mentioned those owing their colours to the presence of gold, copper, and selenium. It is generally considered that these colouring agents exist in the glasses as metallic gold, metallic copper, and elementary selenium respectively, and the varying colours which can be obtained in each case appear to depend on the state of division of the colouring agents, or at least to be associated with it. How far there is evidence that selective absorption of light has also to be taken into account, is a question which can hardly be dealt with in a short time.

With gold the colours most readily obtainable range from red to blue, through varying stages of purples. With copper in the metallic state the common colour is red; but it is possible to get variations very similar to those seen in gold glass, and a copper glass giving a definite blue by transmitted light has been obtained. It is to be understood that this blue was not due to copper in an oxidised condition, but to metallic copper. Selenium glasses are also generally red, but again states of division of this material can be secured which give other colours, although it is difficult, except on a very small scale, to obtain other than greys or neutral tints. With each of these glasses, in which gold, or copper, or selenium is present, quick chilling of the molten glass will, as in the case of opal glasses, yield a clear and colourless glass, and the greater the concentration of the colouring agents, the more sudden must the chilling be to secure this result. On re-heating these colourless glasses they, like the opals, "strike" and yield the colours which could have been obtained by slower cooling of the molten glasses. It may be of interest to deal with a gold glass a little more in detail. It is not easy to get a strongly coloured glass with gold added, in the form of gold chloride, to the batch mixture of an ordinary soda lime glass. Among the substances which enable one to prevent gold separating from the molten glass in the ordinary metallic state, the commonest used are the oxides of lead, tin, and antimony. Bismuth oxide acts similarly, and so also does uranyl oxide. There are physical and chemical problems of much interest involved in this behaviour of these oxides; but it would lead us too far into technical details to attempt their discussion here. A gold glass containing oxide of tin may be chosen, because it can be made so that its behaviour can be studied either in the furnace or in a blowpipe flame. With a suitable concentration of the gold, and very slow cooling of the melt, all the ranges from red by transmitted light to a pale blue can be observed, and if rods are drawn out from the pot at intervals, and examined in a beam of light, it will be seen that, starting from a fine deep red by transmitted light, through the various stages of reddish and bluish purple and blue to the pale blue, there is progressively more and more marked scattering of the light, and the rods look more and more of an opaque brown colour by reflected light, until in the later stages the appearance of precipitated gold is so marked as to leave no doubt that what has occurred has been a progressive aggregation of the gold into larger and larger particles. Microscopical examination of the glass at the different stages gives clear confirmation of this and of the great similarity in the manner of separation of the gold to that of the materials which give opal glasses. Remarks made under opals and crystallisation of glasses about the influence of changing viscosities apply also, in a general way, to gold glass. There is one point in this connection which is worth referring to. If the suddenly chilled and colourless glass be returned, in small pieces at a time, to a pot in a furnace at a high temperature, about 1400° C., the glass can be melted and the gold still retained in it without appreciable loss by separation into the ordinary metallic state; but if it be slowly heated up it passes through the stages of colour previously described, and, after complete fusion at a high temperature, practically all the gold will be found in a button at the bottom of the pot. Now, except in the case

a very soft gold glass, heating and working the colourless glass in the flame will only give a red glass, and no passage through the other stages is seen, or, in general, the glass at any of the stages of colour be worked in the flame, the change of colour is but slight. The explanation seems to be that, throughout the mass of the glass the temperature never reaches high enough to give the state of viscosity for free aggregation of the gold particles, while, on the immediate surface of the glass the temperature may be so high that the gold is retained in solution, as it is in the highly heated furnace. It is very difficult to get a gold glass to behave like some opal glasses, in the sense that it will go clear and colourless in the flame and remain so when quickly cooled; but a copper glass can be made in a similar manner with tin oxide, which will go quite colourless in the flame. Bulbs can be blown from it which remain white on cooling, and the gradual "striking" of a deep red colour observed on gently reheating in the flame. It has been noticed in experiments with some copper glasses that, in the initial stages of "striking," the colour which develops is not red, but a dark neutral tint with a suggestion of olive green in it. This may be from copper in the very finest state of division in which it can exert visible action on light, or it may be due to the presence of traces of oxidised copper in the glass giving rise to the well-known dark compounds of cuprous and cupric copper. Certainly very dark glasses of rather similar tint can be obtained by intentionally allowing some oxidation to take place in the making of a red copper glass, or by fusing together a reduced copper glass with one in which the copper is fully oxidised. At the same time it is worth noting, and is perhaps suggestive, that a chilled and colourless gold glass which goes through the stages of a very pale red to a fine full red on heating in the flame has, after six months' exposure to the β-rays of radium, only developed a dusky neutral tint. A piece of glass of the same composition, except that there was no gold at all in it, has not been affected by the radium. It would lead too much into theoretical discussion to consider in what form gold, copper, and selenium exist in the respective chilled and colourless glasses, and how far they may be looked upon as being in combination, or merely in so fine a state of division that they have no visible effect on light. The chemical and physical evidence that, when they do give colour, they are in the elementary state, seems to be fairly conclusive; but this does not necessarily exclude the possibility of their being in something very like chemical combination in their colourless states.

Perhaps it is needlessly striving after definiteness to attempt to distinguish between bodies being dispersed in an extremely fine state of division, partly at least through chemical attraction for their solvent, and being held in a loose kind of chemical combination. Some consideration of such a question, however, is helpful in suggesting experiments, and some instances may be given. One is in connection with the composition of a glass to give the full possible colour with copper. The notion of something like chemical combination of the copper leads to the study of the effect of varying the relative amounts of the basic and acid ingredients of the glass. More of the basic part, such as the alkalis, might be expected to turn the copper out of combination, and more of the acid part to keep it in. It would be tedious to describe in detail the results of numerous trials with glasses, and the point can be equally well illustrated by simple experiments with borax beads. Copper oxide mixed with about twice its weight of tin oxide can be dissolved in molten borax in an oxidising flame, and then reduced in a reducing flame. On cooling, the bead is either colourless or "strikes" red according to the concentration of the copper. If colourless it can, with suitable concentration, be made to "strike" by reheating. Now, if to the bead which "struck" red on cooling, more boric anhydride be added, and the bead again fused, it will remain colourless on cooling; but, unless too much boric anhydride has been added, it will "strike" red on reheating. Addition now of more alkali, in the form of sodium carbonate, will restore the property of striking red at once on cooling. Similarly it follows that a bead which remains colourless on cooling, but "strikes" on reheating, can be prevented from giving any colour of copper at all by more boric anhydride, and the property of "striking" red on reheating can be restored by the further addition of alkali. Of course, in making these various additions of alkali and acid to the bead, there must be a change in the concentration of the copper; but a bead can be got in so sensitive a condition that a mere trace of alkali will determine whether a red colour is developed or not, and a number of experiments on glasses and glazes do confirm the notion of chemical action playing a part on lines which would be expected from general chemical experience.

When manganese dioxide is added to a glass as a so-called decolorising agent, it is intended to be left in an oxidised condition, so as to give a violet colour which will disguise the green colour due to iron, and produce only a slight darkening of a neutral tint, scarcely visible except in thick pieces of the glass. Sometimes the violet tint is overdone, and can easily be seen, and sometimes so much of the manganese dioxide has been reduced that the green due to iron is fully visible, the lower oxide of manganese giving no colour to the glass. In many instances of glasses in which one would be inclined, from mere inspection, to say that all the manganese dioxide has been reduced in the furnace, it has been found that a strong violet colour can be developed by exposure to radium or by cathode discharge in vacuum tubes. In parenthesis it may be remarked that potash glasses generally give a good violet, and soda glasses a brown or a brownish violet. Using small amounts of manganese dioxide in batch mixtures, as free as possible from iron, it has been found possible to get glasses practically colourless to the eye, some of which readily give colour on exposure to radium for a period during which others develop no colour. In making the latter, the conditions in the furnace were arranged for complete reduction of the manganese dioxide. In making the former as little de-oxidation as possible was aimed at. In one instance, thin rods drawn from the melt of one of these, in which very little manganese dioxide was used, cooled almost colourless, but "struck" quite a marked violet colour on re-heating. This chilled glass was also very sensitive to radium. More urgent work prevented further experiments, but the facts so far obtained are mentioned as relevant to the question of the chemical condition of colouring agents in glasses, and as an illustration of one which would appear to be somewhat of a border line example of the groups (*a*) and (*b*) referred to previously. I am reluctant to dismiss the matter in this rather summary fashion, but the interesting speculations which will occur to many can hardly be dealt with shortly. I would, however, recall the well-known pink or violet colour to be seen in some window glasses which have been exposed for years to daylight. In all examples which I have been able to examine, manganese has been found to be present, and I can imagine that the colour has developed in daylight in a manner similar to that in which it has been found to be developable in manganese glasses by radium, by cathode discharge, or by heat. The colour of the old window glasses is a little puzzling, if they are soda-lime glasses. One would expect them to be browner in tint; but perhaps on insufficient grounds, since no direct experiments have, so far as I know, been made with manganese glasses made with potash and with soda batch mixtures and exposed to sunlight for a long period. It is a matter for regret that when the old tinted window glasses were examined for manganese the idea of the influence on the colour of the alkalis present did not occur. [Having regard to the effect of manganese greatly to enhance the phosphorescence of potash and soda-lime glasses, and to the known coloration of certain potassium and sodium compounds under cathode discharge, it is possible that the colours in the old window glasses described are not due

manganese dioxide itself, but that manganese may have rendered the alkali compounds in the glasses more sensitive to light of short wave lengths. The fact that glasses containing no manganese did not colour under cathode discharge, &c., is not conclusive, since such glasses showed but feeble phosphorescence. The observation, however, that of two glasses containing the same amount of manganese, and giving equal phosphorescence, the one in which there is evidence of some of the manganese being in the higher state of oxidation, becomes very markedly coloured by an amount of exposure to rays which has no visible effect on the other glass in which the lower oxide of manganese only is present, seems at least to point to some special behaviour of manganese dioxide].

The influence of different alkalis and the remarks already made on the effect of varying the relative proportions of bases and acids on the copper glasses, bring me to a short consideration of the behaviour of colouring agents which would generally be placed in group (*b*) as existing in glasses in a state more nearly resembling that of true solution than that which may be considered to obtain in the more colloidal solutions of gold, copper, selenium, and other substances such as silver, sulphur, carbon, &c., with which there has been no time to deal. I must confine my remarks to but few of group (*b*), and perhaps nickel and cobalt will be the most suitable to illustrate the effect of different alkalis and also that of varying proportions of one and the same alkali.

If three similar and moderately soft glasses be made containing respectively potash, soda, and lithia as the alkalis present in chemically equivalent proportions, and if the same amount of nickel oxide be present in each glass, marked difference in the colours is observed. The potash glass is a fine deep violet, the soda glass is almost brown, with only a hint of purple in the brown, and the lithia glass is a yellowish brown with less strength of colour altogether in it than there is in the soda glass. Similar differences can be seen in beads made from nickel oxide dissolved in the bi-borates of the three alkalis. Of these alkalis, potash is the strongest and lithia the weakest base. The glasses mentioned would not be described as acid glasses, but as glasses containing a fair proportion of basic to acid ingredients. If highly acid glasses be made with the three alkalis and the same proportion of nickel oxide, the lithia glass is only slightly coloured a brownish yellow, the soda glass is a lighter brown with no trace of purple in it, and the potash glass is rather darker in shade than the soda glass, but a definite brown. Again, very similar results can be obtained in beads of the borates of the alkalis by varying the proportions of acid and alkali, and using the same amount of nickel oxide in each set of experiments. With potash as the alkali the proportions of boric anhydride and alkali and the concentration of nickel oxide can readily be adjusted to show a bead coloured brown when cold, but becoming a definite violet when heated just below a dull red heat. A like change of colour has been observed in experimental glasses made for studying the colours obtainable from nickel.

With cobalt oxide as the colouring agent, the difference between the blue colours of potash and soda soft glasses is not very noticeable; but a similar lithia glass is less coloured, and there is an appreciable violet tint in the colour. If, however, using any one of the three alkalis a highly acid glass containing the same amount of cobalt oxide be made, the difference between it and the comparable soft glass is very marked. There is much less depth of colour altogether. What there is is a somewhat violet blue in the case of the potash glass, a rather lighter and more violet blue in the soda glass, and a still lighter pink violet in the lithia glass. This nearly pink glass goes to a weak but quite distinct blue when heated.

The effect of the alkalis potash and soda on the colour of borates is not so marked in the case of cobalt as it is in that of nickel. Lithia in comparison with them always gives for equivalent proportions a much more decided violet tint in the blue. The influence of the proportic of base to acid, however, is marked, and can be very we seen by using any one of the alkalis in varying propo tions with molten boric anhydride, to which a sma amount of cobalt oxide (about 0·25 per cent) has be added. [Cobalt oxide dissolves in highly heated bor anhydride, but on cooling cobalt borate separates ou giving an opaque, very pale blue, glassy mass]. Takin lithium carbonate as the alkali and adding only a ver small amount (about 0·25 per cent), the whole of the coba remains in solution on cooling, and the resulting glass i seen to be blue while still hot, to change to a more an more violet tint on cooling, and to be almost a pink whe cold. The addition of more of the alkali intensifies th blue colour, giving greater depth of colour, and the mas when cold is a violet blue. Similar variations in colou can be obtained with equivalent quantities of potash an soda, but the effect of these alkalis is always to give more pronounced blue as the amount of alkali is increase Comparing the weakest base, lithia, then with potash th strongest and progressively adding each to borate bead containing cobalt, no amount of lithia, up to the poir when it is impossible to keep the bead vitreous, will giv as blue and as strongly coloured a bead as the equivalen or even less than the equivalent, of potash will produce There is always a more violet tint in the lithia bead.

In conclusion, a brief reference may be made t another colouring agent, copper oxide. This oxide is nc soluble in boric anhydride when a bead of the latter i heated in an oxidising flame, but by the addition of a alkali a clear blue bead is obtained. Should the alkali, *e.g.* potash, be added in very small amount, so as to give highly acid mixture of about the composition, for instance represented by the portions $K_2O.5OB_2O_3$, the coloratio due to about 0·25 per cent of copper oxide is so faint tha the bead is practically colourless, although this amount c the oxide is sufficient to give a markedly blue bead i potassium bi-borate, $K_2O.2B_2O_3$. In this case, also, the the colour becomes more intense as the amount of alka used is increased.

One is tempted to compare this effect of alkali on th copper oxide and boric anhydride mixture with that water on copper sulphate, which, in the anhydrous stat represented by the formula $CuSO_4$, is white. Th addition of water sufficient to give the compositio $CuSO_4.H_2O$ leaves the substance still white; but wit more water the well-known blue copper sulphat $CuSO_4.5H_2O$ is produced. Without going so far as t call this an example of hydrolysis by water, it may not b too much to speak of the development of colour as ind cating in $CuSO_4.5H_2O$ a greater tendency to the formatio of blue copper hydroxide than is possible with the small mass of water in $CuSO_4.H_2O$.

The notion that there is an analogy here with the pro gressive development of colour in glasses and borate with increase of alkali may be suggested but with rese vations. Still, the changes from brown to violet in th case of nickel, from pink to blue in the case of cobalt, an the progressive development of the colour of copper, a brought about by increasing the proportion of alkali, d seem to point, if not to a definite separation out of th oxides of these metals, to something like it in the sens that with very little of the alkali present the oxides of th metals may be playing a basic part, but are turned out b more of the stronger base (the alkali), and may be eithe freed or caused to play the part of acids to the alkal The study of a wide range of colouring agents in glasse has furnished some facts which, from a chemical point o view, lends plausibility to the notion and others whic seem to need a great deal of interpretation to su port it. As an idea it has been useful in suggestin methods of producing, as well as of preventing, colour i glasses. More facts, however, must be accumulated for fuller and more correct shaping, in its physical an chemical aspects, of one of the many interesting problem connected with glass.

## RAPID DETERMINATION OF CARBON MONOXIDE IN AIR.*

ARTHUR B. LAMB and ALFRED T. LARSON.

(Continued from p. 62).

*Results.*

'S selected from a typical run with a 0·9976 per ixture of carbon monoxide in air are given in I.

.E I.—*Deflection with 0·9976 per cent Mixture of Carbon Monoxide in Air.*

inc D = 1100 ohms. Heating current = 1·1 ampères. ate of flow = 1·5 litres per minute. 1000 ohms lditional resistance in galvanometer circuit. E = 10 ohms and F = 77 ohms. Galvanometer re- istance = 120 ohms.

| . | Galvanometer reading. Cm. | Total deflection. Cm. | Time of adjustment. Min. |
|---|---|---|---|
| 49 air .. .. | −0·3 | | |
| 58 air .. .. | −0·3 | | |
| 10 air .. .. | −0·1 | | |
| 17 air .. .. | −0·2 | | |
| 18 gas mixture | +24·0 | | |
| 19 gas mixture | +22·2 | | |
| 20 gas mixture | +22·0 | | |
| 22 gas mixture | +21·7 | | |
| 23 gas mixture | +21·5 | | |
| : 27 gas mixture | +21·1 | 21·4 | 9·5 |
| : 29 gas mixture | +21·1 | | |
| : 32 air .. .. | +0·7 | | |
| : 35 air .. .. | −0·3 | | |
| : 42 air .. .. | −0·3 | | |
| : 44 air .. .. | −0·2 | | |
| : 46 gas mixture | +22·5 | | |
| : 49 gas mixture | +22·5 | | |
| : 51 gas mixture | +22·3 | 22·5 | 6·5 |
| : 53 gas mixture | +22·3 | | |
| : 55 air .. .. | −0·2 | | |
| : 57 air .. .. | −0·3 | | |
| : 00 air .. .. | −0·3 | | |
| : 03 gas mixture | +22·2 | | |
| : 05 gas mixture | +22·1 | | |
| 1 : 07 gas mixture | +22·1 | 22·5 | 4·5 |
| 1 : 10 air .. .. | −0·7 | | |
| 1 : 12 air .. .. | −0·7 | | |
| 1 : 15 air .. .. | −0·9 | | |
| 1 : 17 gas mixture | +22·2 | | |
| 1 : 18 gas mixture | +22·1 | 22·9 | 3·0 |
| 1 : 20 air .. .. | −1·0 | | |
| 1 : 23 air .. .. | −1·0 | | |
| | | 22·4 ± 0·4 | 5·7 |

Similar results were obtained with mixtures containing ·1 per cent carbon monoxide. The percentage repro- lucibility in both cases was practically identical, being ± 2 per cent over an interval of one to two hours, and ibout five minutes was required to reach a definite leflection.

*Second Method (Catalytic)*

This method depends upon the catalytic combustion of the gas in contact with platinum. At 275—300° this re- action is fast enough, so that combustion is complete under ordinary conditions. The temperature rise is measured by means of a thermo-couple and galvanometer. After calibration, deflections of the galvanometer represent definite concentrations of carbon monoxide.

This method not only proved to be more accurate than the first method but also easier to instal and operate. It was used for many months in routine testing laboratories o the Chemical Warfare Service, and, indeed, made pfossible the rapid development of carbon monoxide masks and absorbents.

*Apparatus.*

Two satisfactory types of apparatus were developed one using a vapour and the other an air-bath to heat the gas and the contact mass. The former apparatus is by far the easier to instal, and it alone will be described in detail in this paper.

A diagram of it is shown in Fig. 3; B was a steel tube 90 cm. long and 7·5 cm. in diameter, closed at one end. The tube was covered except for the upper 25 cm. with several thicknesses of asbestos paper. Boiling dipbenyl- amine was found to give satisfactory results in the vapour-

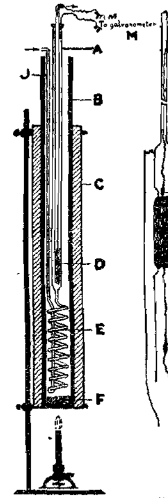



Fig. 3.

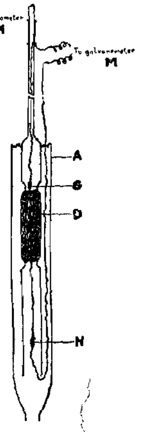



Fig. 4.

bath, though it decomposed slowly and had to be renewed from time to time. Sufficient heat to keep the zone of condensation within 30 cm. of the top of tube B was maintained.

The gas mixture to be analysed was brought to the constant temperature of the vapour-bath by a 4 mm. Pyrex glass tube extending to within 5 cm. of the bottom of the vapour jacket, whence it wound backward in a close coil about 15 cm. long and 6 cm. in diameter, equivalent to a straight length of about 3 metres. Attached to this coil was the Pyrex glass tube A, 15 mm. in diameter and ex- tending about 30 cm. above the top of the steel tube B. Tube D was fitted into A as indicated. This was made from a length of 4 mm. Pyrex glass tubing to which was attached a 20 cm. length of 7 mm. tubing, this enlarged portion being constructed as shown in the figure. This tube carried the catalyst and thermo-element shown in the enlarged cross-section given in Fig. 4. The thermo- couple was made from No. 30 copper and constantan wires, the joints being welded or silver soldered. (If silver wire had been used instead of copper many of the

* Published by permission of Maj.-Gen. W. L. Sibert, Director of Chemical Warfare Service, U.S.A. From the *Journal of the American Chemical Society*, xli., No. 12.

difficulties resulting from the oxidation of the copper would probably have been avoided). The distance between the two junctions was about 6 cm., this portion of the element being made of the constantan wire. The copper leads extended through the rubber connections and were attached to a galvanometer. A wall type d'Arsonval galvanometer, having a resistance of approximately 120 ohms and giving a deflection of about 0·30 cm. per micro-volt on a curved scale 50 cm. from the galvanometer mirror, was used in this work.

### *Catalyst.*

Catalysts were made, some from platinum wire, 0·05 mm. in diameter, and others from platinum gauze, woven from a similar wire. When the wire was used it was wound into the form of a 2 mm. spiral, and then pressed into a fairly compact mass. One grm. of this wire gave sufficient surface for our purpose. To prepare it the platinum was *first cleaned with acid and then covered* with platinum black by electro-plating in a solution of chloro-platinic acid in the usual manner. When a heavy coating had been deposited the wire was washed and then electrolysed, first in dilute sodium hydroxide solution and then in dilute sulphuric acid, during which time the current

testing to be done. The number of points to be dete mined for purposes of calibration was also governed largel by a similar consideration.

(NOTE.—In the testing of absorbents for CO a 1 p cent CO air mixture has generally been used, although o per cent and 0·25 per cent have been found desirable a times. The "break" in the absorbent was usually take as the point at which 0·1 per cent CO leaked through These points on the galvanometer scale are therefore c considerable interest, and it is important that CO ai mixtures of about these concentrations be used in th calibration).

To fix a given point a certain concentration of gas wa drawn through the machine until the galvanomete readings became constant. Two samples of the gas were the withdrawn and analysed by the iodine pentoxide method The concentration was now altered, and a second poin obtained, and so on, for as many points as seemed desir able. *As an illustration, the results obtained in the cal* bration of an electrically heated apparatus (Unit No. 2 New Interior Building Laboratory) are given i Table II.

These results are represented graphically by the soli curve in Fig. 5. The observed deflections are represente

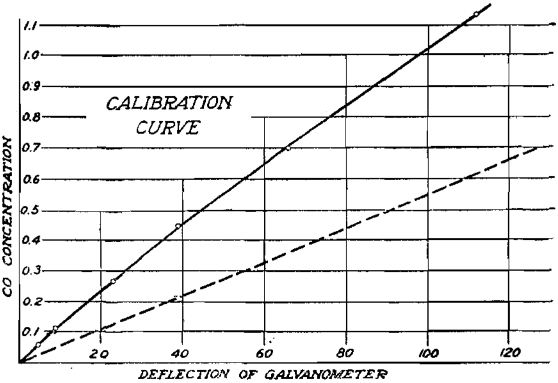



Fig. 5

was commutated as in the previous plating. This operation was found to be absolutely essential to the successful preparation of the catalyst. The catalyst was now washed and dried and placed in tube D, as shown in Fig. 4. Junction G lay near the upper surface of the catalyst, and was as centrally located within the tube as possible. The catalyst was firmly packed into the tube so as to ensure firm lodgment and prevent channels through which the gas might pass without coming into contact with the catalyst.

This method could, of course, easily be made into a continuous recording one by the use of various electrical recording devices now in the market.

### *Calibration.*

The apparatus was calibrated by passing through it air containing known percentages of carbon monoxide. Because variable rates of flow produce variable galvanometer deflections it was necessary to maintain a fixed rate of flow, which rate was governed by the nature of the

by the empirical equation D = 82 (per cent) + 15·5 (per cent)² with an average deviation of only 2 mm.

TABLE II.—*Calibration.*

| CO in air mixture. Per cent. | Galvanometer deflection. Observed. Cm. | Galvanometer deflection. Computed from empirical formula. Cm. | Deviation from empirical formula. Cm. | Deviation from empirical formula. Per cent total air. |
|---|---|---|---|---|
| 0·057 | 4·5 | 4·75 | −0·25 | −0·003 |
| 0·104 | 8·8 | 8·70 | +0·10 | +0·001 |
| 0·264 | 22·8 | 22·73 | +0·07 | +0·001 |
| 0·441 | 39·0 | 39·16 | −0·16 | −0·002 |
| 0·706 | (66·0) (*a*) | 65·61 | +0·39 | +0·004 |
| 1·127 | (111·8) (*a*) | 112·09 | −0·29 | −0·003 |
| | | | ±0·21 | ±0·002 |

(*a*) In these measurements additional resistance had to be inserted in the galvanometer circuit.

It is of interest to compare the above observations with

ld be expected had none of the heat of combus- lost to the surroundings. In this computation fic heat of air is taken as 0·237 at 275—300°, :ular heat of combustion of carbon monoxide as lories, the temperature coefficient of e.m.f. as :rovolts per degree, and the apparent molecular if air as 28·8. The galvanometer showed a n of 0·0323 cm. per microvolt of 1·84 cm. per This would then require a deflection of 183·6 a 1 per cent carbon monoxide air mixture, corre- ; to a temperature rise of 99·66°. This value has :d to draw the dotted line in Fig. 5, representing ılated deflections for different concentrations of nonoxide.

observed deflections for this apparatus are about ıt calculated on this basis, showing that a very 'able dissipation of heat occurs. The gradual ın of the curve representing the observed results ng a lesser relative heat loss for higher con ons and higher temperatures is interesting, and is y explained by the fact that at the higher tem- :s a great increase in the reaction velocity occurs, the reaction zone in the contact mass becomes , and hence the loss of heat by conduction less.

(To be continued).

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, January 29, 1920.*

: J. J. Thomson, O.M., President, in the Chair.

ollowing papers were read :—

*he Genetics of 'Rogues' among Culinary Peas* (Pisum ım)." By W. Bateson, F.R.S., and Caroline EW.

a previous communication (*Proc. R.S.*, 1915, 89) we ed that certain intermediates between types and s in peas had a peculiar genetic behaviour. Families l by self fertilisation from them consist of a small rity of type-like plants and a majority of rogues. minary experiment showed that the type-like plants . from seeds contained in the *lower* pods. Investi ns of the past four years, consisting chiefly of rocal crosses made from successive flowers, have con- :d this conclusion, and have proved further that the of type-like to rogue-like gametes is different on the ıle and male sides. On the female side the ratio is ıt equal for the first ten flowers, after which the pro- ion of rogues increases. On the male side, taking the -like gametes as unity, the proportion of rogue-like for irst six flowers in succession is as follows :—4·6, 4·9, ), 12·3, 29·5. From self-fertilisations the proportion ıd for the first six flowers is 15, 11, 13, 15, 54, over

here is thus a gradational change in successive 'ers. This gradual elision of the type-characters must brought about by a process similar to that which rates more rapidly in the case of $F_1$ plants bred between ; and rogue. These, though containing the type, :d rogues only, the type being excluded in the base of plant.

*Studies of Synapsis. I. Oogenesis in the Hymen- ra.*" By L. T. Hogben.

since attention has hitherto been focussed chiefly on the mentation and polar mitoses, and no account of the ıaptic processes in oocyte development has been given, vas decided to investigate oogenesis in the Hymenoptera, l the following forms were studied :—Cynips kollari, odites rosæ (*Cynipidæ*), Orthopelma lutiolator (*Tirsch*) *Ineumonidæ*), Synergus rheinhardii (*Cynipidæ*), Lasius va, and Formica rufa (*Formicidæ*).

The more salient conclusions arrived at are as follows:

1. Sex determination in fem. agamically produced.—In Cynips and Rhodites (agamic forms) there is reduction of the chromosomes in the young oocyte. The somatic number of chromosomes in Rhodites is 18, as believed by Henking. The "chromosomes" of the young oocyte counted by Schleip are double (bivalent). Henking's belief in the doubling of chromosomes in segmentation is confirmed. Both polar bodies are probably formed as the result of homotypic division.

2. The maturation prophases.—A diploteric and pachyteric stage with the biciploid number of filaments follows synapsis in all cases in the young oocyte. At this stage nurse cells are differentiated.

In Cynips, Rhodites, and Orthopelma the *diploid* number reappears after a "diffuse" stage. These univalents pair end to end, as described by Heynes in Copidosoma.

There are thus two chromosome conjugations in the parasitic Hymenoptera, as described in *Lepidosiren* by Agar, but not hitherto confirmed in other animals by other work. An abortive spindle followed by an atypical formation of polar bodies appears to be general in the Hymenoptera.

3. Secondary nuclei and the oosoma.—Secondary nuclei were observed in the oogenesis of Synergus, Formica, and Lasius. They appear to arise from chromidia ejected from the germinal vesicle at the time when the latter undergoes diminished staining capacity. The "oosoma" arises in Synergus as a cloud of cytoplasmic granules. It is not nuclear in origin.

"*On a Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours.*" By H. Onslow.

The cause of iridescence in insects, &c., still remains unexplained. The minute structure of many iridescent bodies was investigated, because the most eminent physical authorities differed fundamentally as to the cause of their colour. The great variety of structures de- and illustrated show that each object must be ju its own merits, because no general theory [illegible] all cases.

The principal type of colour-producing str in butterflies has not hitherto been described [illegible] of transparent plates of chitin s separated [illegible] These plates are at right angles to the sc[illegible] are only a few half wave-lengths in t[illegible] shape, and colour together control [illegible] saturation. Some butterflies have pla[illegible] parently parallel to the plane of the wing [illegible] show structures whose colour cannot be exp[illegible]

3, 5, 2·1, 12·3, 2·4, 5, 6 } 12·3 (*a*)

Reasons are given showing that the m[illegible] transmission and reflection colours in beetle[illegible] probably not entirely due to "gratings," as wa[illegible] by Michelson. The chief objections to metallic in the case of scales, are not met with in the w[illegible] scaleless beetles. Here the colour-producing layer [illegible] near the surface that it would be difficult for any o[illegible] adequate structure to exist. In certain beetles the colo[illegible] is produced by a thick layer of doubly refractive rods, such that sections tangential to the surface still retain their colour. The wing chitin of golden "Tortoise Beetles" appears metallic at all depths, when moistened, but loses colour when dry.

In other insects and some ticks, the colour returns on wetting, apparently because there is a thin film, which, by absorbing water, becomes transparent, and can cause interference. Iridescence in dragon-flies, the eyes of flies, plants, and certain hairs such as the Golden Mole, is also discussed.

Literary Intelligence.—Messrs. J. and A. Churchill have just ready a new work entitled "A Laboratory Manual of Elementary Colloid Chemistry." The author is Mr. Emil Hatschek, a well known authority on this subject. There are 20 illustrations in the text.

## NOTES.

ROYAL INSTITUTION.—On Tuesday next, February 17, at three o'clock, Prof. Ernest Wilson begins a course of two lectures at the Royal Institution on "Magnetic Susceptibility." On Thursday, February 19, Mr. A. H. Smith delivers the first of two lectures on "Ancient Greek and Roman Life," and on Saturday, February 21, Prof. Sir J. J. Thomson begins a course of six lectures on "Positive Rays." The Friday evening discourse on February 20 will be delivered by Dr. E. J. Russell on "British Crop Production," and on February 27 by Mr. W. B. Hardy on "Problems of Lubrication."

IT is proposed to establish a Refractories Department at the Brierley Hill Technical Institute. A joint meeting of Stourbridge and District Wages and Conciliation Board was held at Stourbridge on Wednesday, January 28. The British Refractories Research Association was represented by Sir William Jones and Dr. J. W. Mellor, the Stourbridge manufacturers by Mr. W. Fullwood and Lieut.-Col. C. W. Thomas, and the operatives by Mr. J. C. Mason. Ald. J. T. Homer, who presided, expressed the views of the Staffordshire Education Committee. Sir William Jones pointed out that the Refractories Research Association did not wish to compete in any way with local enterprise but would do all they could to assist it. The Stourbridge firebrick manufacturers are to be called together shortly to consider the proposals for the establishment of the Refractories Department.

FRENCH COMMERCIAL CHEMISTRY.—The Society of *Industrial Chemistry (Paris)* has put forward a plan which, when realised, will be of the greatest advantage to French commercial chemistry. This i[s] to bring together in Paris, [un]der one roof, the various branches of commercial [chem]istry which have hitherto been separate. The General [Institu]te of Industrial Products and the Society of [Industria]l Chemistry have drawn up statutes for the new [body] which it is proposed to house in an "Institute [of] Chemistry." Membership will be open to [those inte]rested in the practical applications of chem[istry, sci]entists, technicians, and commercial men together by the creation of a research bureau, a library, lecture rooms, work [rooms], conferences. Exhibitions of chemi[cals], commercial transactions, and offices [will] be let to provincial manufacturers and [wi]ll thus be able to obtain an agency in Paris [at small] outlay and a moderate rent. It is frankly [that] the broad lines of the above scheme have [been taken fr]om similar institutions already flourishing in [Brita]in and America. Such an enterprise is quite [an innov]ation in French commercial circles, but for that [re]ason it is expected that it will prove a success, and it will not be long before similar institutions are [orga]nised in connection with other branches of industry.—*[R]euter's Trade Service.*

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## MEETINGS FOR THE WEEK.

*Monday, February 16.*

Royal Geographical Society, 8.30. "The Spanish Zones in Morocco," by H. E. The Spanish Ambassador.

Royal Society of Arts, 8. (Cantor Lecture). "Recent Research in Cellulose Industry," by C. F. Cross, F.R.S.

*Tuesday, February 17.*

Royal Institution, 3. "Magnetic Susceptibility," by Prof. Ernest Wilson.

*Wednesday, February 18.*

Royal Society of Arts, 4.30. "English Canals and In[land] Waterways," by Sidney Preston.

Society of Glass Technology, 3. (At Sheffield).

Royal Microscopical, 7.30.

*Thursday, February 19.*

Royal Society, 4.30. "Studies of Photo-synthesi[s in] Fresh-water Algæ," by B. Moore and T. A. Web[ster]. "Properties of Colloidal Systems—IV., Rever[sible] Gelation in Living Protoplasm," by W. M. Ba[yliss]. "Development of the Auditory Apparatus in Sph[eno]don Punctatus," by the Rev. F. J. Wyeth.

Royal Institution, 3. "Ancient Greek and Roman L[ife]," by A. H. Smith.

Chemical Society, 8. "New Method for the Estima[tion] of Methyl Alcohol," by S. B. Schryver and C. Wood. "$\beta\beta'$-Dichlorethyl Sulphide," by C. Gibson and W. J. Pope. "Some Derivative[s of] Fisetol," by W. K. Slater and H. Stephen. "Ca[lori]fic Value and Constitution," by M. F. Ba[rker]. "Surface Tension of Alcohol-water Mixtures," by J. Firth.

*Friday, February 20.*

Royal Institution, 9. "British Crop Production," [by] Dr. E. J. Russell.

*Saturday, February 21.*

Royal Institution, 3. "Positive Rays," by Sir J. [J.] Thomson.


G. R.

**MINISTRY OF MUNITIONS.**

BY DIRECTION OF THE DISPOSAL BOAR[D] (PLANT AND MACHINERY SECTION).

**FOR SALE BY PUBLIC TENDER.**

**PLANT AND MACHINER[Y]**

TENDERS to be received not later t[han] 10 a.m., FEBRUARY 28th.

STEAM WINCH

by Sykes. Lot No. 78, two cylinders, on channelled iron and slee[pers] Vertical Boiler, 10 ft. by 4 ft. 4 in., with 4-wheeled Trolley, 50 6 mm. coil Steel Rope.
Ref. G. 1986, M.K. No. 22023.
Lying at The Kite Balloon School, LYDD.

EDGE RUNNER MILLS,

Grinding Mills, and Runners, Mortar and Pestle of Wedgewo[od] No. 5 on their Catalogues.
*Ref. G. 1676, M.K. 17628/32.*
Lying at Royal Gunpowder Factory (Lower Store), WAL[THAM] ABBEY.

DISINFECTING MACHINE,

Petrol driven, by Clayton and Co. Type M, complete wit[h] lengths of Armoured Hose, each 15 feet long, with couplings. gas from this machine is effective within twenty minutes.
Ref. G. 1977, M.K. No. 21908.
Lying at The Barracks, OSWESTRY, S.D.

SILICOL PLANT AND TANK.

Admiralty type B, for the production of Hydrogen Gas. Constr[ucted] by Messrs. S. Cutler and Sons to produce 10,000 cu. ft. per [hour]. Overall dimensions 20 ft. by 11 ft. by 20 ft. Comprising Soda [Tank] and Tray, Generating Chamber, Water Storage Tank, Scrubbe[r], Separator, 1½ h.p. Motor for driving the stirring gear, complete [with] Starter, Piping, Valves, Staying, &c. Overall dimensions of Staying, &c., built of 9 in. by 4 in. timber.
Ref. G. 1332, M.K. 21497.
Lying at The Balloon Station, SHEERNESS, KENT.

Fuller particulars of the above, together with Tender Form[s] permits to view, can be obtained on application to the CONTRO[LLER] D.B. 1 E., Embankment Buildings, Charing Cross, W.C. 2.

NOTE.—For particulars of other Government Propert[y for] sale see "SURPLUS," price 3d. at all bookstalls, [or] quarterly subscription of 2/- post free, payable in advan[ce to] the Director of Publicity, Ministry of Munitions, Whi[tehall] Place, London, S.W. 1.

CHEMICAL NEWS.

Vol. CXX., No. 3123.

## RAPID DETERMINATION OF CARBON MONOXIDE IN AIR.*

ARTHUR B. LAMB and ALFRED T. LARSON.

(Concluded from p. 83).

### *Longevity of Catalyst.*

ccessful operation of this device depends upon the ence of the platinum catalyst. Anything which ange the character of the platinum black surface npair and in most cases completely destroy its ic properties. A high temperature, for instance, will the platinum black to a grey, which is considerably tive than the black. It was therefore important not iat there should be sufficient platinum to complete nbustion of the carbon monoxide present, but also iis surface should be in such excess that the heat ted per unit area of its service was not great enough ct the conversion to the grey variety.

introduction of halogens into the gas stream pro- permanent poisoning of the catalyst. When this the catalyst must be removed from the apparatus ashed in hot nitric acid, or even replated in some in order to bring it back to its former activity. ur compounds were also injurious to the contact e, but in such cases drawing pure air through the d catalyst frequently restored it to its former effective- The effect of sulphur dioxide on the catalyst is i in Table III.

ABLE III.—*Effect of Sulphur Dioxide on Catalyst.*

entration of CO, approx. 0·2 per cent. Temperature iir-bath, 300°. Unit No. Ia.

| Time. | Gal. deflection. Cm. |
|---|---|
| 5 : 20 | 25·3 |
| $SO_2$ *introduced 1 part per* 100,000 (by volume) | |
| 5 : 23 | 24·6 |
| 5 : 26 | 23·3 |
| 5 : 30 | 23·1 |
| 5 : 35 | 22·6 |
| 5 : 40 | 21·9 |
| 5 : 45 | 21·2 |
| 5 : 50 | 20·5 |
| 5 : 55 | 19·8 |
| 6 : 00 | 19·1 |
| 6 : 05 | 18·4 |
| 6 : 10 | 17·7 |
| 6 : 15 | 17·0 |
| 6 : 16 $SO_2$ off. | |
| 6 : 17 | 19·0 |
| 6 : 19 | 19·6 |
| 6 : 30 | 19·6 |

t will be noted that the rate of "fatigue" is propor- ial to the time, being 0·7 cm. for each five-minute in- val. When the sulphur dioxide was turned off, the vanometer deflection increased and finally reached a istant value, though one lower than at the outset. If temperature be raised to 350° and air passed at the ne time, this poisoning effect can be entirely removed.

* Published by permission of Maj.-Gen. W. L. Sibert, Director of iemical Warfare Service, U.S.A. From the *Journal of the merican Chemical Society*, xli., No. 12.

A few of the most frequent sources of halogens and sulphur compounds which were encountered and which must be guarded against deserve mention. When carbon dioxide is made by the dehydration of formic acid, the concentrated sulphuric acid used suffers slight decomposition into sulphur dioxide. Again, when the gas is dried by *bubbling* through concentrated sulphuric acid, enough acid spray is carried along with the gas to give trouble. Rubber connections made from fresh cold-cured rubber give off sulphur chloride and must be heated in strong alkali before use. The air with which the carbon monoxide is being diluted often causes trouble. It was found advisable to draw the air from out of doors, in order to eliminate every possibility of contamination. Some absorbents give off gases which produce poisoning effect, in which case provision has to be made for their removal.

When precautions were taken to avoid these rather patent sources of contamination no difficulties were experienced. The same catalyst mass was often employed almost continuously for many weeks without replacement. It is advisable, however, when a machine is in constant use, to check its reading against a reference gas once a day, or bettter still, before and after prolonged series of tests. Any slight poisoning of the catalyst would then be disclosed and correction for it could be made.

### *Accuracy of Catalytic Method.*

An estimate of the accuracy of this method can be gained from the close agreement of the observed galvanometer deflections obtained with different concentrations of carbon monoxide in calibrating an apparatus; for instance, No. 11a, with the empirical formula D = 85 (per cent) + 15·5 (per cent)², characteristic of it. As can be seen from Table III., the average percentage deviation here from the formula was ± 0·002 per cent over the whole range, based on the air.

TABLE IV.—*Reproducibility of Deflection with* 0·1 *per cent CO Air Mixture.*

Concentration of CO = 0·117 per cent (by volume). Rate of flow = 1·47 litres per minute. Temperature of bath = 275°.

| Time. Mins. | | Galv. deflection. Cm. | |
|---|---|---|---|
| 0 | Air | 0·3 | |
| 1 | 0·1 per cent CO | 10·5 | |
| 3 | | 12·1 | |
| 5 | | 12·3 | |
| 6 | | 12·4 | 12·3 (*a*) |
| 7 | | 12·5 | |
| 8 | | 12·6 | |
| 10 | Air | 0·7 | |
| 14 | | 0·5 | |
| 16 | | 0·3 | |
| 19 | | 0·3 | |
| 21 | 0·1 per cent CO | 12·3 | |
| 22 | | 12·4 | 12·3 |
| 24 | | 12·6 | |
| 25 | | 12·6 | |
| 26 | | 12·6 | |
| 30 | Air | 0·4 | |
| 33 | | 0·3 | |
| 35 | 0·1 per cent CO | 12·0 | |
| 36 | | 12·5 | 12·3 |
| 37 | | 12·6 | |
| 38 | | 12·6 | |
| 41 | Air | 0·5 | |
| 44 | | 0·3 | |

(*a*) When these values are referred to the calibration curve (Fig. 4) it will be noted that the galvanometer deflections are greater than one would expect for gas of this concentration. The pure carbon monoxide used in this test had been kept in galvanised tank for some time, and the high reading is no doubt due to the added heat of combustion of the hydrogen which had accumulated in the tank.

The reproducibility of the readings is shown by Table IV., where observations made when air and a 0·1 per cent carbon monoxide mixture were alternately drawn through the machine are recorded.

It is evident that over this interval the galvanometer readings are reproducible to within a millimetre, or to within 1 per cent; this corresponds to an absolute reproducibility in this mixture of 0·001 per cent carbon monoxide based on the total air.

Table V.—*Comparative Efficiencies.*

Carbon monoxide canister. A, thermometric method. B, iodine pentoxide method. Against 1 per cent CO air mixture.

Canister No. 20.

| Mins. | 5 | 45. | 120. | 165 | 1 5 | 235. | 248 |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·2 | 0·3 | 0·5 | 1·0 | 1·5 | 4·8 | 10·0 |
| Per cent leakage by B.. | 0·5 | 1·0 | 1·1 | 1·2 | 2·1 | 4·7 | 11·7 |
| Per cent B − per cent A | −0·3 | −0·7 | −0·6 | −0·1 | −0·6 | −0·1 | −1·7 |

Canister No. 21.

| Mins | 5 | 45. | 120 | 165. | 200 | 230. | 254. |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·2 | 0·1 | 0·3 | 0·5 | 2·4 | 5·1 | 9·7 |
| Per cent leakage by B.. | 0·3 | 0·0 | 0·6 | 0·6 | 2·5 | 5·0 | 10·5 |
| Per cent B − per cent A | −0 1 | 0·1 | −0·3 | −0·1 | −0 1 | 0 1 | −0 8 |

Canister No. 22.

| Mins. | 5 | 45. | 120. | 156 | 170 | 180 | |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·3 | 1·1 | 1·7 | 5·3 | 9 8 | 15 7 | — |
| Per cent leakage by B.. | 0 8 | 1 4 | 1·8 | 5 7 | 10 7 | 16·1 | — |
| Per cent B − per cent A | −0 5 | −0 3 | −0 1 | −0·4 | −0·9 | −0·3 | — |

Canister No. 23.

| *Mins* | 5. | 45. | 120 | 165. | 176 | 183. | |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·1 | 0·4 | 0 8 | 5 0 | 10 3 | 15 3 | — |
| Per cent leakage by B.. | 0 0 | 0·0 | 0·5 | 4·6 | 8·9 | 15 5 | — |
| Per cent B − per cent A | 0·1 | 0 4 | 0·2 | 0·4 | 1·4 | 0·2 | — |

Canister No. 24.

| Mins | 5 | 45. | 120 | 165. | 184 | 200 | 215. |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·0 | 0·1 | 0 2 | 1·4 | 4 9 | 9·8 | 15·0 |
| Per cent leakage by B.. | 0·0 | 0 0 | 0·0 | 1·1 | 4·8 | 10·5 | 15·3 |
| Per cent B − per cent A | 0·0 | 0·1 | 0 2 | 0·3 | 0·1 | −0·7 | −0·3 |

Canister No. 25.

| Mins. | 45 | 120 | 150. | 190. | 21[illegible]. | | |
|---|---|---|---|---|---|---|---|
| Per cent leakage by A.. | 0·4 | 1·2 | 5·0 | 9 6 | 14 7 | — | — |
| Per cent leakage by B.. | 0·8 | 1·1 | 4·6 | 10·3 | 14·5 | — | — |
| Per cent B − per cent A | −0·4 | 0·1 | 0·4 | −0·7 | 0 2 | — | — |

The reliability of this device in the estimation of carbon monoxide is further shown by the results tabulated. This table (Table V.) contains the results of a series of carbon monoxide canister tests in which the iodine pentoxide method and this thermometric method were both used in testing the effluent gases. At every point where ar[e] analysis was made by the chemical method a similar analysis was made by the thermometric device. The fine agreement of the two methods shows the new one to be entirely trustworthy.

Assuming for the moment that the values obtained by the iodine pentoxide method are correct, the average discrepancy of the above results by the thermometric method is only 0·38 per cent. At first glance this might appear to be a large average where such small quantities (0·2—10·0 per cent) are concerned, but when it is remembered that the tests are made on a 1 per cent gas and that therefore this percentage variation corresponds only to an error of 0·0038 per cent on the total air mixture, it will be recognised that this represents a very excellent agreement. This agreement is especially satisfactory when it is remembered that the results were secured in routine runs under the stress of war-time demands.

Actually, since the thermometric method was calibrated by means of iodine pentoxide, the above discrepancies are essentially accidental, and should not all be charged to the thermometric method. In other words, the real discrepancies are presumably somewhat less than 0·0038 per cent.

Summarising our observations regarding the accuracy of this catalytic method (Method No. 2), we should say that at least on mixtures of 0·1 to 1 per cent of carbon monoxide the method can reasonably be relied upon for an accuracy of ± 0·003 per cent, based on the total air.

*Summary.*

1. The necessity for an accurate and rapid method fo[r] the analysis of dilute carbon monoxide air mixtures in th[e] study of gas mask absorbents for carbon monoxide ha[s] been explained.

2. Two thermometric methods answering this require ment have been described. In the first method the ga[s] mixture is passed over a platinum wire heated to redness and the carbon monoxide is partially burned in contac[t] with it. The gas mixture is then freed of carbon mon oxide by passing through heated copper oxide, and i[s] brought back in a thermostat over another identica[l] platinum wire heated by the same electric current. Th[e] first wire is the hotter because of the combustion whic[h] occurs on it—and the resultant relative change in th[e] resistance of the two wires serves as a measure of th[e] concentration of the carbon monoxide. In the secon[d] method the mixture is passed through a platinised platinu[m] catalyst when the carbon monoxide is completely burn[t]. The temperature rise is measured by a thermo-eleme[nt] and indicates the concentrations of the carbon monoxide.

3. Both methods are rapid. The latter is particular[ly] accurate, easy to instal and to operate. With reasonab[le] precautions the activity of its catalyst remains constant [;] that machines have been in constant satisfactory operati[on] for many weeks at a time. Being very nearly instantaneo[us] *these methods are particularly useful for continuo[us]* analysis of a changing gas mixture. Attempts to app[ly] them to the analysis of flue and combustion gases a[re] already under way.

## EQUATION OF RADIATION.

The specific heat and consequently the intensity or te[m]perature Eλ of monochromatic radiation varies inverse[ly] with $m$ in the equation $m^x = k/\log T$, and the wave-leng[th] λ *of maximum emissivity for any specific substance, al[so]* varies inversely with $m$, where $m+3 =$ the degrees [of] freedom of the molecule. $dm/dT = -T^{\frac{2}{x}} x^{-1} k^{-x}$. F[or] hydrogen $x = 1$ and $dm_1/dT = -T^2 k_1^{-1}$. The size [of] the oscillating molecule increases with $m$, and the dista[nce] apart of the nodal or ventral electrons which give [the] characteristic radiation, increases in proportion to $m$.

nean kinetic energy with three degrees of freedom, perates in radiation, radiation pressure, or gas is always equal to that of an hypothetical mon-nolecule at $m = 0$ where $T = \infty$. The mean energy, with $m$ degrees of freedom, is exactly the mean kinetic energy previously deduced for ation of condition (CHEMICAL NEWS, cxxi., 4) $pv = m^xT$, so that the total energy U in a u solid is doubled and for a gramme atom $^xT$. The energy is similarly doubled for a gas volume-pressure be included. Combining this inck's formula for the mean energy of an oscilla- $= 3\lambda^4 E\lambda c^{-1}$, Rayleigh's radiation equation is d in the form $E\lambda = cm^xT\lambda^{-4}$ but with the variable place of the constant R or R/N so that the uncies in the shorter wave-lengths are now recti-d the molecule, which is also the oscillator, is a cle for energy of any quantum. Energy is only in when in the form of ethereal waves. As $\lambda$ ches zero so also does $m$, so that $E_\lambda$ has a finite g value according to the value of $x$ for any specific ice.

n radiation in dynamical equilibrium, as in a Prevost er, one semi-vibration will eject an electron by the ion of a disposable ether atom, and the completion one vibration will again replace an electron by the on of the disposable ether atom. This is the physical of Kirchhoff's laws of emission, absorption, and ening radiation. The reflectivity, absorptivity, and nissivity would be graphic linear ratios of the ent wave-length. The mechanisation of any physical pt should be preliminary to mathematicisation; as, bsequent, Newtonian mechanics, continuous time, Euclidean space are liable to distortion.

## SYNTHETIC DYES.

### A TYPICAL "KEY INDUSTRY."

he issues of the *Journal* of November 27 and Decem-11 last we dealt with the position of those "Key istries" to which it is the policy of the Government xtend special encouragement and protection until they e become securely established in this country. In all hem the country was almost wholly dependent on ign imports—chiefly from Germany—and when war ke out suddenly in August, 1914, and imports from my countries were immediately cut off, a grave situa-n arose in many industries which were dependent upon ey" products. To name a few of the more obvious ses—We had no British-made magnetos with which to n our motors; the manufacture of fine chemicals and ıgs was almost non-existent, and as our hospitals came filled so the cry for more drugs and antiseptics creased; we had no commercially productive source of tash on which the artificial manure industry depended, d with the institution of the submarine campaign and e attempt to starve us out there was an urgent need for tificial fertilisers; British supplies of chemical and ptical glassware did not amount to one-tenth of our peace quirements and were quite unable to meet the demands f the Army and Navy; we had a large hosiery industry, nd the demand for naval and military clothing made its xtension an urgent matter, but we had no hosiery machine eedles, without which the whole machine is useless; inally, we had no synthetic dye industry of any size, and without a sufficient supply of these dyes our all-important colour-using industries—probably the largest group of pro-ducing industries in the country—could not be carried on at a time when every ounce of increased production which could be attained was vitally necessary. In all these in-dustries the Germans were supreme, and almost without knowing it we had been content to place ourselves at their mercy. Such a disastrous situation must never be allowed to develop again.

*Dyes as Natural Keys.*

In the present article we are, however, only concerned with synthetic dyes, and, as will be seen subsequently, the claim of this industry to be regarded as a "key" is even stronger than would appear at first sight. Lord Moulton, in a speech delivered at Manchester in December, 1914, stated that as a result of the investigations which he had made as Chairman of a Government Committee appointed to examine the position which Britain was placed in by the cessation of supplies from Germany, it was evident that in many cases the resources of British enterprise would, in a short time, be sufficient to meet the demand, and that, if not removed altogether, the difficulties would be alleviated. "But," he said, "everything that has hap-pened has placed in harsh and dissonant contrast the question of dyes. Nothing that I have seen during these weeks—and I can claim to have spent almost every hour of the day in meeting the members of the trades affected, and in trying to find some way out of the difficulty—nothing that I have seen in these long weeks has weakened —nay! I can say nothing has failed to strengthen my feeling of the gravity of the problem. . . . In my opinion we are at a crisis of our national fate."

*Position in August, 1914.*

What, then, was the position at the outbreak of hostilities? Briefly, the United Kingdom was consuming about 20,000 tons of dyes, valued at slightly less than two millions a year, of which about 90 per cent came from Germany. On this two million pounds worth of dyes were dependent industries which, in exports alone, accounted for over two hundred million pounds worth of our national purchasing power, to say nothing of the many million pounds worth of dyed and coloured goods utilised within our own borders. The textile industries, employing at least a million and a half of workpeople, were dependent upon dyes; then came the manufacture of paints, printing inks, ordinary writing inks, the leather trade, the paper-making trade, and a host of other miscellaneous business, including the preparation of foodstuffs, many of which derive their distinctive colours from the pervasive dye-stuffs.

*The Pre-war Dye Industry.*

*Immediately the war started and the position as regards dyes became apparent, discerning men in all industries realised the need of developing a domestic dye industry. It was seen that we were only producing about one-tenth of our requirements, but investigation showed that our dependence on Germany was greater even than these figures showed at first sight. Through force of competi-tion British dye-makers had as a generalisation been com-pelled either to join the various German conventions, and submit to the dictations of the Germans as regards the extent and scope of their manufacture, their selling prices, and the delimitation of their markets, or else they were crushed out of existence. Thus our industry—such as existed—was far from self-contained, the Germans having reserved the manufacture of the most important processes for their own factories. The British industry was in reality a tributary dependent on the German industry, and the Germans merely tolerated it as long as it suited their purpose to do so. And so demarked from other industries is the coal-tar chemical industry that there was no other industry able to lend a helping hand when the crisis came.*

*Help from Switzerland.*

There were practically no stocks—whether by accident or design—as it was the practice for the agents to replenish their stocks twice a year, the consignment for the second half of the year usually being received about the beginning of August. The only country from which we could expect any help at all was Switzerland, on which country Ger-many put the most intense pressure to prevent the United Kingdom from securing Swiss dyes. The Germans threatened to stop the supplies of "intermediates" to

Switzerland, and when the Swiss refused to give way they carried out their threat, and from that time onwards put every possible obstacle in the way of the Swiss sending supplies to this country. Fortunately the British Government was able to step in at one and conclude a bargain with the Swiss which, without doubt, was the means of saving our industries, whereby we agreed to supply Switzerland with raw materials in return for finished dyestuffs. This arrangement still holds, and those who are aware of its working in practice and the loyalty with which it has been observed on both sides know best how we owe to it. But, after all, merely to transfer our dependence from one country to another was no satisfactory solution of the problem. It might be a temporary expedient, or at the best an alternative source of supply. The vital necessity was for the creation of a strong home industry which would ultimately render us independent of all foreign sources.

*Chemical Warfare.*

That was the situation in 1914. Since that date we have learned much as to the need for a self-supporting organic chemical industry, and have often suffered for the lack of it. As the war progressed in bitterness, and resort was had by our enemies to various forms of chemical warfare, we realised that our very existence as a nation was jeopardised by the inattention which had been paid to organic chemistry, and by the want of encouragement of the organic chemist. So little was the importance of the chemist understood that eighteen months after the war started we actually had a Government establishment advertising for chemists—men of University training—at the salary of 45s. a week—an amount at that time little more than a labourer's wage! In Germany, on the other hand, it was said that about one man in every 60 was a chemist, or had had a chemical training. No German works was without its chemist, who superintended the carrying out of manufacturing operations with scientific precision. It is true that the German system of training tended towards specialisation, but even so the number of chemists was large enough to provide a fruitful recruiting ground for the army of research workers and trained scientists required to carry on a chemical warfare. And in the prosecution of this chemical warfare, as in the carrying on of the whole war, Germany was always dependent on the great dye-making factories situated in the Rhine area. Without the wonderful plant at Oppau working the Haber process for the fixation of nitrogen and the preparation of ammonia from the air, Germany could not have carried on the war for two years. The plant provided thousands of tons of nitric acid, which is absolutely necessary for the production of explosives. Without it, and in consequence of cessation of the supplies of Chilian nitrate due to the blockade, Germany would have been forced to her knees in a few months. The Haber process has not yet been worked on a commercial scale outside Germany. In peace time the Oppau plant seemed harmless enough, as then it was occupied in the production of ammonium sulphate—one of the three most important fertilising materials. Even to-day few people outside a very restricted circle realise its potential importance. Had we, too, been cut off from supplies of nitrate from Chile, with no Haber plant to make up the deficiency, it is impossible to say even now how enormously our difficulties would have been increased.

*Dye Plant and War Munitions.*

What is true of Oppau and the Haber process is even more markedly true of the remaining German dye factories as a whole. Some years before the war a combination was formed of the Bayer, Badische, and Berlin Aniline Companies, whilst a little later a second group was formed consisting of Cassella, Meister Lucius and Bruning, and Kalle. These two groups amalgamated during the war, and at the same time took in the Greisheim-Elektron, Weiler-ter-Neer, and Leonhardt Companies—the whole combination becoming known as the Interessen-Geme[...]schaft (the I.G.). The companies named made, i[n] addition to ammonia and nitric acid, all the poison g[...] (except some of the simpler gases, chlorine and phosgen[e]) used by Germany, and a large proportion of the high e[x]plosives. But the most significant feature is that the b[ulk] of these products were manufactured in plant which [in] peace time had been utilised for the production of dyes [and] pharmaceutical products. Practically no adaptation w[as] necessary, and immediately on the determination to wa[ge] a chemical war Germany was able to make use of existi[ng] plant for the manufacture of noxious gases. On the co[n]trary, we in this country, where we had no establish[ed] organic chemical industry, were compelled to design a[nd] experiment with new plant and processes, with the res[ult] that many valuable months elapsed before output co[uld] begin. These months might have lost us the wa[r]. Another striking fact in connection with the manufactu[re] of explosives and poison gases in Germany was t[he] practice of allocating different stages of manufactu[re] among various factories according to the suitability of t[he] plant available for a particular process. This enabl[ed] Germany to achieve a maximum output in a minimu[m] time, but the practice was only rendered possible by t[he] organisation of her chemical industry.

Figures are available showing the enormous extent [to] which the German dye factories provided the means f[or] carrying on the war, and though these cannot be quot[ed] here, the above facts will serve to show how rapidly t[he] peace-time organisation of the German dye industry co[uld] be diverted to war purposes, thanks to its highly train[ed] personnel and great technical resources. At the prese[nt] moment, in consequence of the general economic co[n]ditions in Germany, the scarcity of materials and t[he] difficulties of labour, the German dye works have beco[me] almost impotent, but this condition is only tempora[ry]. Sooner or later they will reassert themselves and on[ce] more become what they always really were—vast, p[ro]spective arsenals ready at a moment's notice to chan[ge] over from peace time to war time work almost as eas[ily] as an English factory changes its shifts. For milita[ry] security alone it is essential that we secure with the utm[ost] speed a fully organised and self-supporting orga[nic] chemical industry. Any country entering a war witho[ut] the support of a well developed chemical industry with[...] so under a very severe handicap.

*The Training of Chemists.*

Leaving military considerations on one side for[...] moment, the establishment of an organic chemical indu[stry] is necessary in order to provide scope for scientific rese[arch] work and a training ground for young chemists. [As] already hinted, in the past we have paid too little atte[ntion] to the chemist, and only now are becoming fully awa[re of] his true importance. That we were not altogether la[cking] in chemical talent is proved by the fact that the first co[al] tar dye was discovered by an Englishman, and for a ti[me] the United Kingdom was the only country produci[ng] synthetic dyes. How was it then that we lost the [in]dustry, with all its wonderful prospects, especially as m[ost] of the raw materials necessary were available here [in] ample quantities? The real reason was the want of e[n]couragement of the chemist. The tendency in t[his] country was to divorce industry from science, whereas [in] Germany they went hand in hand. So it occurred th[at] whilst an Englishman made the initial discovery it w[as] left to the German to appreciate its importance a[nd] develop it. The war has opened our eyes. The future [no] doubt has many remarkable developments in stor[e, but] none will be so striking or so revolutionary in char[acter as] those which will emanate from the laboratory.

*The British Dye Industry.*

Having said so much as to the reasons wh[ich im]pelled three successive Governments to [...] give the assistance to the British dye industry in the[...]

s rapid establishment, it may be advisable to review y the progress that has been made and to give a al indication of the present position. As already ated there were one or two firms making dyes in and at the outbreak of war. The most important of were Read, Holliday, and Sons, Huddersfield; astein, Ltd., Manchester; Claus and Co., Ltd., Maner; the British Alizarine Co., Ltd., Silvertown; the ;on Aniline Co., Ltd., Manchester; and Messrs. H. N. is and Co., Ltd., Manchester. In addition there two factories—one at Ellesmere Port and the other omborough Port, both on the Mersey—operated by German Dye Companies, in order to comply with the nt Act of 1907. Early in 1915 it was decided to form v national company with Government financial assist, and British Dyes, Ltd., came into being, took over work of Read, Holliday, and Sons, and commenced erection of new works adjacent to the old factory. r on Messrs. Levinstein absorbed the works of Claus Co., and also purchased the Port Ellesmere factory the Government, by whom it had been previously ) over. Last year Messrs. Levinstein and the British , Ltd., amalgamated to form the British Dyestuffs oration, Ltd. Messrs. Morris have continued to make ie oil and salt, whilst the Clayton Aniline Co., which ned the Society of Chemical Industry in Basle, made y intermediate products for supply to the latter, but w engaged on the extension of its range of production. British Alizarine Co., which, as its name implies, alises in the manufacture of alizarine, gradually in-ed its output until the works were practically destroyed n exposion at a neighbouring munition factory in ary, 1917. It was some time before the company re-ed from the effects of this explosion, but by the end 18 its output had been doubled and new extensions ow in hand, which, when complete about six months e, will increase the production to four times that of . In addition several other concerns of varying im-nce have taken up manufacture, with the result that resent output of dyes is not less than 25,000 tons per m. These figures, while recording a remarkable evement, having regard to all the difficulties of the war are, however, somewhat misleading in that it does ow from them that British consumers of dyes are y able to obtain all their requirements from British of supply. There are many gaps in the range of oduced by the British makers, but nevertheless the 1 is distinctly hopeful, and there is every ground for ef that the main difficulties inherent to the creation omplicated an industry as the coal-tar chemical y have been successfully surmounted. The founda-well laid. It remains now to extend and develop. the Germans forty years to reach their present 1, and it cannot be expected that we can attain the osition, even with the valuable stimulus of a five-ar period, in much less than ten to fifteen years. the proposal for the temporary protection of the y for a limited period.

*Our Shortage of Dyes.*

ertheles, in spite of the progress that has been made hopeful outlook for the future, it cannot be denied present we are short of dyes! The situation at the t is abnormal. For several months after the ce the expansion of trade was slow, then in the onths of 1919 came a sudden revival. The demand ll over the world was for more and yet more tex-Manufacturers were inundated with orders, and them could dispose of their output many times In turn these manufacturers clamoured for dye-such variety and quantity that the dye manufac-ine utterly unable to cope with the demand for the be. The change from war time to peace time ies the the textile world, instead of being spread ing it a period, came very rapidly. Other in-y. Such also affected, and the dye makers found they were faced with a shortage of raw materials in many directions. At present they are unable to get new plant, partly owing to the prolonged moulders' strike, but mostly because of the general congestion in the engineering industry, where deliveries are more difficult to get even than in the case of dyestuffs themselves. But, after making allowance for all our present difficulties it is a fact that this country is in a better position as regards the supply of dyes than any other country. America may have supplies of some dyes, but the American range is much more restricted than the British. Switzerland is very short of raw materials and coal, and has been compelled to close down one factory altogether on this account. Germany certainly has considerable stocks of some dyes, but half of these is under option to the Allies, whilst her current production is only about 20 per cent of the normal, or even less. This favourable position of the British industry will become more marked when our superiority as regards the supply of many essential raw materials is fully felt. The position was summed up a few days ago by a prominent Lancashire manufacturer (whose business is very largely dependent on fast dyestuffs), who said that in his opinion, if we were in possession of ample supplies of every dye which every manufacturer would like to have, the increase in output from the loom would scarcely be noticeable. The variety of shades might be different, and the ultimate markets might change, but he was convinced that such was the state of things at present that there was absolutely no difficulty in selling every yard of cloth that could be produced.

*The Options on German Dyes.*

The Allies have an option on 50 per cent of the stock of dyes existing in Germany at a certain date—August 15, 1919. This provision, together with a further option on 25 per cent of the output of the German factories for a period of five years from the coming into force of the Treaty—January 10, 1920—was inserted in the terms of peace, in order, first, that the supplies so obtained would help to tide us over the difficult period of reconstruction until our home dye industry was fully established, and, secondly, to prevent the Germans from utilising their position as monopolists in certain colours, as was their practice in the past, to damage the British industry by preventing the supply of particular colours which we require, except in conjunction with others, of which ample supplies are available from British sources.

*Necessity for Self-dependence.*

Everything points to the fact that we shall have to depend on ourselves for the bulk of the dyes which we need in the near future, with such assistance as we can get from Switzerland. It is therefore necessary that we do not allow the present abnormal position to obscure our vision and the desire for more dyes to warp our better judgment. If we are to be sure of our dyes—apart altogether from the military importance of the matter, which has already been explained—we must have a dye industry in the country strong enough to meet our needs, and no efforts should be spared to secure this object.—*Board of Trade Journal.*

## THE POTASH INDUSTRY IN GREAT BRITAIN.

A ᴠᴀʟᴜᴀʙʟᴇ paper by E. C. Rossiter and Cyril S. Dingley contains the results so far obtained from an examination of the possible production of potash from the blast furnaces of England and Wales. This is one of the three industries in this country in which potash occurs as a by-product, the other two being cement-making and wool-washing. In the blast furnace, the greater portion of the potash charged into the furnace is carried into the slag; the flue-dust obtained from the flues, stoves, and boiler settings will provide only a small portion of the potash re-

quirements of the country, and then only of a very variable and inferior quality. As the po ash in the slag is not recoverable, it is essential, in order to make a potash industry worth while, to adopt a method whereby the volatilisation of the potash and, in consequence, the proportion carried by the furnace gases are increased. This involves the modification of the present method of blast-furnace management, so as to include the addition of salt to the furnace charge, and the provision of adequate means for cleaning the furnace gases. The authors arrange the information they have obtained under the following heads:—(1) The sources of the potash in the furnace charge. (2) The potash content of the flue-dust. (3) The distribution of the potash in the blast-furnace products. (4) The increased volatilisation due to the addition of salt to the furnace charge. (5) Analytical notes on the estimation of potash carried by the furnace gases. As regards (1), an examination of the materials used in the manufacture of pig-iron shows, as was to be expected, that the chief source of the potash is the iron-ore. Taking into consideration the average potash content and the average weight of various ores used per ton of pig-iron produced, it is found that the potential potash production, estimated as KCl, per ton of pig-iron produced, varies with the different ores between 10 lbs. and 40 lbs. The limestones and cokes do not, as a rule, contain more than about 0·1 per cent of potash, estimated as KCl, or about 3 to 5 lbs. per ton of pig-iron made, though occasionally they may contain as much as 13 to 14 lbs. (2) The flue-dusts, provided they contain sufficient potash, and have been burnt in stoves or under boilers, can be used without further preparation in agriculture, and are therefore valuable as a source of potash. They vary considerably as regards their potash content, even when obtained from the same works. The heavy dust, *i.e.*, that obtained from the downcomer, heavy dust catcher, and the flues adjacent to the furnace, contains a little potash, the amount varying from a slight trace to 2·05 per cent of potash, stated as KCl. The dust from the stoves and boiler settings is usually valuable, the soluble potash varying from 3 per cent $K_2SO_4$ with 4 per cent KCl to 30·5 per cent $K_2SO_4$; the insoluble potash varies from 3·6 to 11·4 per cent, stated as KCl. The authors have not been able to estimate carefully the quantity of dust from the stoves and boilers per ton of iron made, but an estimate made in America indicates that it is about 12 cwt. of dust per 100 tons of iron, or about 2½ lbs. of KCl per ton of iron. As this amount is less than 10 per cent of the potash contained in the furnace charge, it is evident that the systematic collection of this dust will provide only a very small proportion of our potash requirements, and, owing to the low potash content of many samples, will be suitable only for local use in agriculture. (3) The potash charged into the blast furnace comes out either in the slag or in the gas. In the slag it probably occurs combined with silicates and in the gas as a very fine fume which, after cooling, may contain the potassium in several forms, though usually it is found as a very constant quantity of chloride, with varying amounts of carbonate and a smaller quantity of cyanides. The fume is so fine that a sample of the gas drawn into a hot aspirator shows no signs of settling after remaining for several hours. In those works which do not cleanse their gas, most of the potash eventually escapes up the chimney, after the gas is burnt at the boilers and stoves, and is evident in the white fume issuing. A small proportion is deposited in the heavy dust catcher, and a larger proportion, but less than 10 per cent, as stated above, collects in the stoves and boiler flues. Only that portion of the potash which is carried by the furnace gases is available for the manufacture of potassium salts, unless the small quantities of stove dust are also utilised for this purpose, and it is therefore very important to determine the quantities of potash present in the gas and in the slag at every blast furnace. In a table, these figures are given for 34 furnaces, and show in the main that, except in the case of ferro-manganese furnaces, a comparatively small portion of the potash is present ⁿ as the Interessen-G conditions of blast-furnace pracompanies named ma amination of furnaces making it acid, all the pois found that in these furnaces, working chlorine and pho slag and at a high temperature, the wttion of the hi was volatilised, showing that a highly re is that th furnaced at high temperatures will volatilise a plant wh The addition of salt to the furnace charge is n of d and the effects of this addition have been studie in February, 1917. The results are, however, at present from being complete, owing mainly to the difficulty obtaining complete control of the furnace conditions o a sufficient period. The authors find in general, howev that there ensues a considerable increase in the volatilis tion of the potash, with a consequent reduction in t potash content of the slag, especially in those cases which the flue-dust, before the addition of the salt, cc tained only a low percentage of alkali salts. It is not that in those furnaces where an adequate gas-cleani plant is installed the extra potash is removed without t incurrence of any additional cost beyond that for the s added. (5) The difficulties of obtaining average sampl of the gas are discussed, and the apparatus used f sampling and measuring are described. Throughout t experiments the potassium salts have been determined l precipitation as potassium platinic chloride.

The authors conclude from their experiments that potash industry obtaining raw materials from the bla furnaces of England and Wales will be able to obta from this source potassium salt equivalent to some 63,0c tons of KCl per annum, or, taking into account reasonab developments, the amount may be placed at 80,000 to per annum as KCl, equivalent to some 50,000 tons potash expressed as $K_2O$. This potential output from th source indicated above may be taken as approximatel double the pre-war consumption of this country. (*Journ of the Society of Chemical Industry*, Nov. 29, 1919).—*Technical Review*.

## REPORTS ON CEREALS.

THE *Bulletin* of Agricultural and Commercial Statistic for January, 1920, just published by the International In stitute of Agriculture of Rome will increase the interest s widely felt as to prospective supplies of cereals during th spring and summer months of 1920.

Information is to hand from Australia stating the yiel of the new wheat crop at 12 million quintals as compare with 22 millions last year, and 31 millions on an averag which is normally 35 per cent of the production of whea in the southern hemisphere.

In alleviation of the unsatisfactory results of the cro just reaped, it should be mentioned that stocks of whe from previous harvests amounting to 18 million quintal were still in existence in Australia on December 31, 1919

As the normal Australian consumption is 10 million quintals, the exportable surplus for 1920 should be 2c million quintals, a quantity considerably above the annual average pre-war export.

The area under wheat in Argentina indicates a decrease of 12 per cent as compared with that of the previous year, and of 9 per cent on the average from 1913 to 1917.

The normal yield of wheat in Argentina provides 50 per cent of the aggregate for the southern hemisphere. There is in Argentina also a considerable remainder from the previous wheat crop in stock and in process of shipment. Very active tonnage engagements have taken place for grain loading from Argentina during the next few months.

As regard autumn sowings for the 1920 wheat crop in the northern hemisphere, the most notable feature is the large decrease in areas under winter wheat and rye in the United States amounting to 23 per cent as compared with those sown for the crop of 1919. For wheat the comparison

its rapid establishment, it from 1913 to 1917 shows a ly the progress that has condition of the wheat and ral indication of the 919, was about an average one. cated there were on ited States wheat crop of 1919 land at the outbrea but 2 per cent as compared with e were Read,
instein, Ltd., of wheat are reported as in favourable ter; the Bly, Japan, and Morocco, while in Great ton Anl elgium the outlook is about average.
wing to severe drought in early autumn, not more than er cent of the usual wheat area had been sown in mania at the end of 1919.
ie prices quoted for wheat in the *Bulletin* are still ly those officially fixed; those for Canada have been iderably advanced in the current month, subsequently he completion of large purchases by the Allied ernments.
ie cotton tables indicate an extraordinary advance in s, as the industrial demand for good qualities of n appears to exceed the supply and quotations are at el never previously recorded.

ne, January, 1920.

## LIGHT AND HEAT FROM GAS.

### The Interests of Consumers.

re.—At a private deputation to the President of the d of Trade several points were made of considerable est to the consumers of coal-gas for lighting, heating, power purposes. The following memorandum is fore issued for public information).

deputation from the Fuel Economy Committee of the sh Association for the Advancement of Science ed recently on the President of the Board of Trade in to bring before him certain considerations which, in view, should receive full weight in legislation re- ting the supply of gas. The deputation consisted of W. A. Bone, D.Sc., F.R.S., Sir Robert Hadfield, W. H. Patchell, and Mr. H. James Yates.

of. Bone, Imperial College of Science and Techno- , called attention to a report on Gas Standards which been made to the Board of Trade by the Fuel Re- h Board, to the conclusions of a conference between sentatives of consumers, local authorities, and gas rtakings in regard the Research Board's report, and statement made in the House of Commons by Sir kland Geddes that a Bill would be introduced to give t to the recommendations of the Fuel Research d. As the British Association Committee had not an opportunity to present their views to the Research d they had asked permission to lay those views before President. They looked at the whole question of gas dards primarily from the point of view of national ests, and generally from that of domestic and in- rial consumers. They agreed that the basis of charge e consumer should be the actual number of thermal supplied to him in the gas which passed through his r. They would, however, substitute in the Board's nt proposal the words "ascertained net calorific e" of the gas for the words "declared gross calorific e." What mattered to the consumer was the actual ing effect he received from the gas supplied to him as rtained by independent tests. The Research Board, h had originally recommended a pressure of not than two inches of water at the exit of the con- r's meter, had since reduced its proposal to a pres- of not less than two inches of water in any main or ce pipe of two-inches diameter. What mattered to consumer was the adequacy of the pressure in his pipes and not the pressure outside in the gas mains. as also of great importance that as constant a pres- as possible should be maintained. The Committee also of opinion that gas undertakings should be compelled to pay great attention to the removal from gas of the highly poisonous cyanogen compounds. Dr. Bone went on to say that the Fuel Research Board had ap- parently acquiesced in the view that the chemical com- position of the different grades of gas were a matter of indifference to the consumer. Scientific research ex- tending over forty years had, however, proved that the chemical character and modes of combustion of the gases which made up coal-gas did profoundly affect their uses for power and heating purposes. He pointed out that coal-gas consisted chiefly of three gases with widely dif- ferent properties:—Hydrogen, methane (a hydro-carbon), and carbonic oxide. Hydrogen and methane were not poisonous, but carbonic oxide was exceedingly poisonous. It was therefore necessary in the interests of the health of consumers that the proportion of carbonic oxide in gas as supplied should be limited. He showed by means of a series of diagrams, taken from experiments, that hydrogen and carbonic oxide, when mixed with air in varying proportions, gave a very wide range of explosion. The range of explosion with methane and air was, on the other hand, very short. Methane had the effect of reducing the explosive range of hydrogen and carbonic oxide. In order, therefore, to diminish the risk of back firing and of accidental explosions due to escape of gas the proportion of methane should not be allowed to fall below a certain point. Dr. Bone further showed by means of other diagrams—obtained photographically by exploding hydrogen and air, and carbonic oxide and air, in a closed steel bomb—that hydrogen and air exploded with a sharp "kick," while the explosion of carbonic oxide was more gradual. Since a quick explosion was bad for gas power machinery the proportion of hydrogen in coal- gas used for power must not be too high. The conclusion of the Committee was that the proportion of methane in coal-gas should be not less than 20 per cent, and the per- mitted proportion of carbonic oxide not more than 20 per cent.

Mr. Yates said that in the view of the Committee the minimum number of thermal units should be not less than at 450 B.Th.U. net. If gas undertakings supplied gas of lower heat efficiency a large part of the existing gas appliances would become useless.

Sir Auckland Geddes said that he had listened to Dr. Bone's exposition with much interest. The basis of charge should clearly be the actual calorific value of the gas supplied to consumers. He would consider the views of the Committee in regard to pressure. He had been impressed with the physiological side of the question and with the danger of cyanogen and of too high a proportion of carbonic oxide gas. Leaks of gas frequently occurred. He would give full consideration to the opinions and facts which had been submitted to him.

## DEFENSIVE SCIENCE IN GAS WARFARE.

The prizes and certificates gained by students at the Sir John Cass Technical Institute, Aldgate, were distributed by Lieut.-Colonel P. S. Lelean, C.B., C.M.G., Professor of Hygiene, Royal Army Medical College, on the evening of *Tuesday, February* 3, *when the chair was taken by the* Rev. J. F. Marr, M.A., who has succeeded Sir Thomas Elliott, K.C.B., as chairman of the Governing Body.

Subsequent to the distribution, Colonel Lelean gave an address on "Defensive Science in Gas Warfare," in which he described the preventive measures that had been adopted to meet its onset and evolution. After referring to the initial attack on April 23, 1915, when the civilised world was aroused to just anger by the news that the Germans had broken their pledged word in respect to the use of poisons as a means of injuring the enemy, Colonel Lelean dealt with the means of protection first adopted in the form of pads soaked in sodium thiosulphate, of which

no less than 98,000 were distributed to the front within sixty hours of the attack, 300,000 within a week, and 2,000,000 within a month, a truly notable achievement, which was only rendered possible by the combined efforts of scientists, manufacturers, and voluntary helpers.

With the recognition of gas attacks as an established adjunct of modern warfare, this temporary device was succeeded by the more efficient protective appliances which were called for by the advent of toxic, paralysing, and lachrymatory gases such as carbonyl chloride, hydrocyanic acid, and chloropicrin, which culminated first in the adoption of the "p" helmet, of which nearly 27,000,000 were issued between July, 1915, and the final withdrawal in February, 1918, in favour of the now well-known "box-respirator."

A full description was given of the great difficulties that were met with stage by stage during the development of these protective appliances, especially in respect to the need for the complete absorption of the small percentages of the poison gases concerned together with the fundamental requirements of comparative ease of breathing and exhalation.

Colonel Lelean paid a special tribute to the outstanding services of Sir William Horrocks and to the late Colonel Harrison in this connection; also to the many scientific helpers with whom they were associated, and particularly to the gallantry and devotion to duty of the small band of scientists who had served under him and upon whom had devolved the practical testing of the efficiency of the many devices which were experimented with in a "lethal chamber" before their issue to the fighting forces could be justified.

In speaking of the helpful war work contributed by the staff of the Sir John Cass Technical Institute, Colonel Lelean expressed the view that it was to such Institutes that the nation looked in its hour of scientific need, and had not looked in vain, and that it is to such Institutes also that with an ever increasing appeal we shall have to look for victory in the future strife of industrial competition, that can only be won by superior technical skill.

In conclusion, Colonel Lelean spoke of the blatant self-complacency with which the Germans had so long vaunted the supremacy of their scientists, that the world had begun to accept them at their own valuation. When, therefore, their equally over-rated army failed to win the anticipated easy victory by fair means, they summoned their alleged supermen, their scientists, to get to work as low down as possible in the hope that the surprise of this blow below the belt would stagger us. What was the result? When once the first incredulous surprise was over and we had mobilised our scientists to meet theirs, the result was never again in doubt. Our scientists were able to defeat theirs at every turn and twist in the sordid conflict that they had forced upon us, until at last the men who had elected to fight a foul war—beaten, cringing—appealed through Switzerland in February, 1918, that the means which they had adopted with such gloating eargerness should be abandoned by mutual consent.

## OIL PRODUCTION IN ENGLAND.

Sir John Cadman, Professor of Mining (Dean of the Faculty of Science at the University of Birmingham), takes an optimistic view of the future of Great Britain as an oil-producing country. Speaking at the dinner of the Birmingham University Mining Society on Thursday last, he said he did not know if we realised how very largely we were dependent for oil upon foreign supplies. Was it unnatural in these circumstances the price of petrol should increase? He thought the veil was about to lift. We possessed within our dominions great potential possibilities of oil. With regard to home oil it was not improbable—in fact, he would almost go so far as to say that success was assured. Drilling in this country was undertaken as the result of scientific reasoning, and the first yielded oil. It had been clearly demonstrated t[illegible] exist in this country, and all we had to do was [illegible] necessary structure to get oil in commercial [illegible] He was bold enough to think that it would [illegible] success, although years would be taken in dev[illegible] Finally, he emphasised the close connection wh[illegible] would have to be in the future between the oil [illegible] industries.

Sir Frederick Black, in responding to the "The Mining and Petroleum Industries" (which [illegible] posed by Mr. C. Grant Robertson, the new Pri[illegible] the University of Birmingham in succession to S[illegible] Lodge), remarked that there was no end to the [illegible] ment that would occur in the oil trade in the [illegible] years. There was no need to regard coal and [illegible] any way in conflict with one another. We were [illegible] work together. There was going to be a use fo[illegible] coal and oil that could be produced. If it was tru[illegible] only scratched the surface by going down a mile f[illegible] he was sure it was true in parts of the world where [illegible] found that the surface had only been scratched.

Col. R. S. Williamson, who also responded, [illegible] out that we must have coal, and as an old mining e[illegible] he said there was no profession in the country whe[illegible] had better facilities or a better chance of getting [illegible] in the mining profession.

This was the first appearance at a public func[illegible] Mr. Grant Robertson since his appointment as P[illegible] of the University, and he observed that his appoi[illegible] might have caused some legitimate apprehension [illegible] University because, as they knew, science and [illegible] science played a large and distinguished part [illegible] curriculum of the Birmingham University, and tho[illegible] had no right to call himself a scientist, he could assur[illegible] that elsewhere in university life he had had a grea[illegible] to do with the advancement and promotion of uni[illegible] science, and he could say he had done what he co[illegible] that direction in a university not always supposed [illegible] in the forefront in science. But he took the deep[illegible] terest in the science department, and if it lay in his [illegible] to promote the welfare of the department he should [illegible] Science had a real friend and a real advocate in hi[illegible] There never was a time in the history of the country [illegible] there was more need of real science in the proper se[illegible] the term. Their society was doing work of the [illegible] greatest value, especially in building up a bridge [illegible] strengthening the bonds between the University tea[illegible] science and the industry itself. That to his mind [illegible] very important work. If they were going to have [illegible] more flourishing school of mining in the University [illegible] connection between the industry and the best in the [illegible] versity was vital. Their Society was doing a work o[illegible] highest university importance and therefore of nat[illegible] importance.

University of Birmingham.—Sir Oliver Lodge, [illegible] has just retired from the position of Principal of [illegible] University of Birmingham, urges in his last report to [illegible] Council the appointment of assistant professors, and [illegible] gests that the appointment of associate-professors [illegible] be contemplated. The latter might, he says, be dr[illegible] from local men of learning and special knowledge. [illegible] suggested further that subjects like physics and chemi[illegible] might be subdivided. The regulations for the Ph.D. [illegible] search degree are now in force, but in view of the pre[illegible] pressure of students the hope is expressed that stud[illegible] from foreign parts will not be coming immediately to t[illegible] advantage of it. The new Dean of the Faculty of C[illegible] merce is Sir John Cadman. A portrait in oils of Dr. P[illegible] F. Frankland, F.R.S. (by Munns), until recently Profes[illegible] of Chemistry, has been given to the University by a C[illegible] mittee. Dr. Frankland is succeeded by Prof. Gilbert Morgan, from the Finsbury Technical College.

## PROCEEDINGS OF SOCIETIES.

### SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

*Annual General Meeting, February 4, 1920.*

Dr. SAMUEL RIDEAL, President, in the Chair.

[Th]e following were elected as Officers and Council for [th]e ensuing year :—

*President*—Alfred Smetham.
*Past-Presidents*—Leonard Archbutt, Edward J. Bevan, Chaston Chapman, Bernard Dyer, Otto Hebner, [Sa]muel Rideal, E. W. Voelcker, J. Augustus Voelcker.
*Vice-Presidents*—W. J. A. Butterfield, G. N. Huntly, Rudd Thompson.
*Hon. Treasurer* Edward Hinks.
*Acting Hon. Treasurer*—E. W. Voelcker.
*Hon. Secretaries*—P. A. Ellis Richards, E. Richards [Bo]lton.
*Other Members of Council*—F. W. F. Arnaud, W. [Ba]con, F. H. Carr, H. G. Colman, G. D. Elsdon, P. J. [Fr]yer, R. Hellon, H. Hurst, C. A. Keane, S. E. Melling, W. Monnier Williams, W. Lincolne Sutton.

*Ordinary Meeting.*

Mr. ALFRED SMETHAM, President, in the Chair.

[C]ertificates were read for the first time in favour of [Me]ssrs. Herbert John Evans, B.Sc., F.I.C.; Cornelius [Ga]rbam Garbutt; Henry Atlas; John Carmichael, F.I.C.; [Ma]urice S. Hutchinson, B.Sc.; Geoffrey Martin, D.Sc., [Ph].D., F.I.C.; Robert Leitch Morris, F.I.C.; James [Wo]od, M.A., B.Sc., F.I.C.; Douglas Henville, F.I.C.; [Be]njamin Richards James, F.I.C.

A Certificate was read for the second time in favour of . William John Read, M.Sc., F.I.C.

The following were elected members of the Society :—[Me]ssrs. Percy Ewart Bowles, F.I.C., Ph.D. (Heidel[ber]g); Charles Crowther, M.A. (Oxon), Ph.D. (Leipzig); [Joh]n William Hawley, B.Sc. (Lond.), A.I.C.; Ernest [Jos]eph Lush, B.A. (Cantab), A.I.C.; H. Percy Marks, [B.S]c., A.I.C.; Robert Selby Morrell, M.A. (Cantab), [Ph].D. (Wurzburg), F.I.C.

The following papers were read :—

*An Investigation into the Composition of the Un[satu]rated Hydrocarbons present in Coal Gas.*" By F. S. [Si]natt, M.B.E., M.Sc. (Tech.), F.I.C., and L. [Sl]ater, M.Sc. (Tech.), A.I.C.

The authors separated the bromine compounds of the [uns]aturated hydrocarbons present in coal gas in sufficient [amo]unts to enable them to carry out a separation of the [mor]e volatile compounds. Their experiments show that [the] percentage composition of the unsaturated hydro[carb]ons present in coal gas is as follows :—

| | 1st experiment. Per cent. | 2nd experiment. Per cent. |
|---|---|---|
| Ethylene .. .. .. | 84·0 | 84·3 |
| Propylene .. .. .. | 13·4 | 11·8 |
| Butylene .. .. .. | 1·75 | 2·35 |
| Amylene .. .. .. | 0·97 | 1·54 |

*The Estimation of the Available Oxygen in Sodium [Per]borate and in Perborate Soap Powders.* (Carried out [und]er the Society's Analytical Investigation Scheme). H. TRICKETT, F.I.C.

[T]he most favourable conditions for the potassium per[man]ganate and potassium iodide volumetric methods [are] given.

A gas volumetric method based on the following reaction : $NaBO_3 + CaOCl_2 + H_2O = NaH_2BO_3 + CaCl_2 + O_2$, is claimed to be as reliable as the given iodometric method, and has the further advantages of greater rapidity and direct applicability to soap powder mixtures.

### SOCIETY OF GLASS TECHNOLOGY.

A MEETING of this Society was held at Stourbridge on Wednesday, January 21. During the forenoon, through the kindness of the respective directors, members had an opportunity of visiting the works of Messrs. Stevens and Williams, Ltd., Brierley Hill; Messrs. Thos. Webb and Sons, Ltd., Dennis Glass Works; Messrs. Thos. Webb and Corbett, Ltd., Coalbournhill Glass Works; and Messrs. King Bros. (Stourbridge), Ltd., Stourbridge.

After a lunch at the Talbot Hotel, at which members outside the Midland area were the guests of the local manufacturers, the general meeting was held in St. Thomas's Hall. The President of the Society, Mr. S. N. JENKINSON, occupied the Chair.

At the outset it was unanimously agreed to send a message of greeting to the newly formed Glass Division of the American Ceramic Society.

In replying to a vote of thanks to the local manufacturers, Mr. J. S. WILLIAMS-THOMAS, J.P., O.B.E., said that the old days of suspicion and jealousies had passed away, and they were all now more inclined to help each other. The prosperity of the glass trade depended upon manufacturers working together and in doing all they could to keep abreast of modern machinery and methods.

One Collective and seven Ordinary members were elected.

Three papers were then presented to the meeting, the first by Dr. W. E. S. TURNER, being entitled "*The Factory Inspection of Glassware.*" He laid stress on the importance of sending out from works only good reliable articles. A sound glass industry could only be built up on a reputation for quality. He said that every article to be decorated should be carefully examined in the blank, as thereby much waste could be avoided. Reference was also made to a recent decision by Japanese manufacturers that all articles of glassware which they exported should pass certain tests. The importance of this was emphasised and a simple form of testing apparatus was exhibited.

Lieut.-Col. C. W. THOMAS followed with a paper on "*A Glass-house Pot of Special Construction.*" A sample of the pot was available for inspection. It was made by Messrs. E. J. and J. Pearson, Ltd., of Stourbridge, partly as an experiment. It was in two parts, the crown being made separately and placed in position afterwards. There was a jointing cushion of asbestos rope between the two portions, each of which was suitably grooved to hold the packing in position. The object in making such a pot was to enable the interior surface of the pot to be worked upon when in a hard and toughened condition. The pot was made in a solid mould with a core, the clay being rammed into a dense body with a wooden rammer during the process of manufacture. The result was a much stronger and denser body than was the case with the ordinary hand-built pot.

The third paper, by F. W. HODKIN, B.Sc., A.I.C., and W. E. S. TURNER, D.Sc., was entitled "*The Relative Durabilities of Potash and Soda Glass for Artistic and Table Ware.*" In summarising the results that had been obtained, Dr. Turner said a soda-potash glass was more durable than a glass composed either entirely of potash or entirely of soda.

Each paper was followed by a discussion.

A Suggested Improvement in the Manufacture of Glasshouse Pots.

The object is to enable the interior surface of the pot to be worked upon when in a hard and toughened condition. It is known that the life of the pot is improved if this can be done, and it is the ordinary practice on the Continent with pots which are made in moulds to beat the inside surface after it has become hard with a beater in order to produce a dense and tough skin. In the case of covered pots it is impossible to do this, because the required condition of hardness and toughness is not reached until some time after the crown has been put on.

It has previously been suggested to make a covered pot in two halves, the lower part being approximately an ordinary open pot, and the crown being made separately and placed in position afterwards. The chief objection to this is that anything in the nature of an open joint between the two parts of the pot would permit of the ingress of dust or furnace gases. To obviate this it is proposed to fit a jointing cushion of asbestos rope between the two portions, each of which is suitably grooved to hold the packing in position. From the result of a similar adaptation of an asbestos cushion for other work, it is found that it makes a thoroughly effective gas-tight and dust-tight joint, and it can be applied either loose or, if desirable, can be cemented into the groove with a suitable fixative.

The particular pot shown has been made in a solid mould with a core, the clay being wrought into a suitable condition and rammed into a dense body with a wooden rammer during the process of manufacture. This results, as will be seen, in a much stronger and denser body than the ordinary hand-built pot, and the process has the additional advantage that any desired proportion of grog can be made use of without the usual disastrous results on the pot-maker's hands.

The pot was made partly as an experiment to test the soundness of the author's views on the method of manufacture, and he would be glad to receive any criticisms which may be offered (see paragraph, p. 93). It should be added that the arrangement shown is not patented, and that it is put forward as a suggested improvement in pot making which is open to the trade as a whole.

## NOTICES OF BOOKS.

*Popular Chemical Dictionary*. By C. T. Kingzett, F.I.C., F.C.S. Pp. vi+368. London: Baillière, Tindall, and Cox, 8, Henrietta Streeet, W.C. 1920.

Mr. Kingzett's book makes a new departure as far as the style of the book is concerned. We have many dictionaries of chemistry, such as Dr. Watts' and Dr. Thorpe's, but these are for those educated in the science.

The author has endeavoured to compile a volume wherein is given in simple language descriptions of the subjects of chemistry—its laws and processes, the chemical elements, the more important inorganic and organic compounds, and their preparation or manufacture and applications, together with illustrated descriptions of chemical apparatus. These descriptions have been so simply written that the uninitiated into the science of chemistry should find the explanations quite easy to follow.

The author, when writing of a chemical compound, has given in brackets its chemical composition, and when giving the natural source of a substance he has given both its popular name and its systematic nomenclature according to botanists, bacteriologists, &c., as the case may be. These points are very useful and it greatly enhances the value of the book.

Other interesting details of the book include the many tables; for example, under "Alcohol" is a table showing the specific gravity of absolute alcohol at different temperatures, and under "Alloys" is given a table showing the composition of the commoner alloys. The aton weights for 1920 are included and are to be found unc "Atomic Weights."

For those who are wanting a book to give them a cle definition of a particular substance or expression as us in chemistry this work should prove invaluable.

*Industrial Gases*. By H. C. Greenwood, O.B.E., D.S (Manchester), F.I.C. Pp. vii+371. Baillière, Tinda and Cox, 8, Henrietta Street, Covent Garden. 192 Price 12s. 6d. net.

This book belongs to the Industrial Chemistry seri edited by Dr. Samuel Rideal.

The author's aims in writing this book are, to give general account of the manufacture and technical ma pulation of gases, to describe the development and gener principles of industrial gas technology, and to present collection of data likely to be useful in connection wi such technology.

The first 57 pages are filled with explanations of t more fundamental physical and physico-chemical principl forming the basis of technical gas reactions. This chapt will be found most interesting as well as useful, f numerous curves and equations are included. At the e is given a table which runs into 3½ pages of collected d which are useful in connection with technical g problems.

The book is now divided into three parts:—Part . "Gases of the Atmosphere," in which the properti modes of manufacture, estimation, and applications a fully explained. This part includes a chapter on ra gases, argon, helium, xenon, &c. The knowledge these gases is brought right up to date. In writi about the applications of helium the author mentions proposed use for filling balloons owing to its non-infla mability and its high lifting power, which is 92 per ce of that of hydrogen, and in connection with this he me tions that a process of isolation has been worked out America, where plants have been erected with an outp of 50,000 cubic feet per day of 93 per cent helium at cost of about £20 per 1000 cubic feet.

Part II. deals with hydrogen, carbon monoxide, carb dioxide, and other gases which have a commercial valu

The author gives a great deal of information on t properties, manufacture, and applications of hydroge for this section runs into 84 pages.

Part III., "Gaseous Fuels," includes producer ga water gas, coal gas, and many other gases which are n so widely known.

The book contains at the end of each chapter a valua table of references, and two indices are given, one subjects and one for the names of authors.

The author is to be congratulated on his work, whi should be very useful to chemists and engineers wh work leads them into the manipulation of industrial gas

*The Journal of the Institute of Metals*. Vol. XX 428 pp. and 31 plates. Edited by G. Shaw Sco M.Sc. 1919, The Institute of Metals, 36, Victo Street, London, S.W. 1. 31s. 6d. net.

A book which should be in the hands of every metallurg and engineer is the *Journal of the Institute of Metals*, t twenty-second volume of which has just made its a pearance, and which contains, amongst other valua matter, a verbatim report of the Ninth May Lecture Prof. F. Soddy, M.A., F.R.S., on "Radio-activity," a the Communications and Discussion at the recent Sh field Meeting, which it will be remembered proved succ great success.

Amongst the many practical papers contributed th may be noted one on "Season Cracking," by Dr. W. Hatfield and Captain G. L. Thirkell, A.I.F., B.Sc.

which provoked such an interesting discussion at itumn Meeting, and one by a lady metallurgist, Miss Fry, and Dr. W. Rosenhain, F.R.S., on "Observa- in a Typical Bearing Metal." Dr. F. C. Thompson aptain F. Orme, M Met., contribute some valuable on the the constitution and metallurgy of Britannia whilst the properties and manufacture of standard are dealt with by Messrs. E. A. Smith, A.R.S.M., '. Turner. Investigations on "The Ternary Alloys a-antimony Arsenic" form the subject of a com- ation by Dr. J. E. Stead, F.R.S., and Mr. L. J. er, M.A. Prof. C. H. Desch's Second Report to Beilby Prize Committee on the solidification of s from the liquid state is a communication touching ndamentals of engineering work, as is an exhaustive on "Moulding Sands for Non-ferrous Foundry ," contributed by Prof. P. G. H. Boswell, O.B.E. useful pieces of work include notes by Dr. F. C. pson on "Graphite and Oxide Inclusions in Nickel ." "The Micro-mechanism of the Ageing of amin" by Dr. Zay Jeffries, of America, and a ole "classic" by Mr. R. E. Leader on "The Early y of Electro-silver Plating."

volume concludes with an invaluable section of 70 pages devoted to abstracts of papers relating non-ferrous and allied industries, which have been led from the transactions of scientific societies and chnical press of the whole world. These abstracts : found indispensable by those who, without undue , would keep in touch with recent scientific progress. publication, notwithstanding heavy increases in the production, continues to come up to its high pre- andard, and is published at the offices of the Institute als at 31s. 6d. net.

## BOOKS RECEIVED.

Chemistry of Colloids." By R. ZSIGMONDY and B. SPEAR, B.A., Ph.D., with a Chapter on Colloidal Chemistry and Sanitation," by J. F. ORTON, S.B., Ph.D. London: Chapman and all. Pp. vii+288.

Analysis." By A. H. GILL, S B., Ph.D. Ninth lition. London: J. B. Lippincott Co. Pp. 215. 19. Price 10s. 6d. net.

tical Metallurgy." By T. TURNER, M.Sc., R.S.M., F.I.C. Second Edition. London: C. riffin and Co., Exeter Street, Strand, W.C. 2. Pp. +108. 1919. Price 3s. 6d.

## NOTES.

MERCIAL ENTERPRISE IN THE VIBORG DISTRICT.— enting upon the commercial possibilities of the district His Majesty's Vice Consul states that enter- y British firms should take the line of appointing it agents of good standing or sending commercial ers periodically, with samples, who could study the of the market. The town of Viborg used to be a er of the Hansa Union, and has had a lively com- l intercourse with German ports, but many German ts could be replaced by British if these were ener- ly pushed by the means suggested. The products ed by His Majesty's Vice Consul are as follows:— il goods, coffee, rice, fruit—dried, fresh, and —cereals, herrings, salt, glass, pottery, household , hardware, pigments, iron and steel (bars, &c.), g materials, metals, fittings, wool and cotton piece oils, varnishes, and rosin. In addition the local cturing concerns wish to buy from the United m all materials required for soap works and tobacco s.

MR. F. H. CARR, F.I.C., has been elected to a seat on the Board of Directors of the British Drug Houses, Ltd. After holding for several years the Salters' Research Fellowship, first the Pharmaceutical Society's Research Laboratory, and afterwards at the Imperial Institute, where he specialised on the active principles of drugs, and became a leading authority on alkaloids, Mr. Carr was appointed Chief of Messrs. Burroughs Wellcome, and Co.'s Chemical Department. In 1914 he was appointed a Director of Boot's Pure Drug Company, from which position he resigned at the end of the war.

PRICE OF QUICKSILVER IN SPAIN.—Taking into con- sideration the price of quicksilver on the London market during the month of December, and the average rate of exchange per pound sterling, the management of the Minas de Almaden has fixed the price of the bottle of quicksilver, containing 34,507 kilogrms., at 329 pesetas as from January 20. If the goods are placed on wagon by the Company at the station of Almadenejos the price will be 331 pesetas the bottle.

THE Merchandise Marks Committee met recently at the Board of Trade, with Mr. Joseph Hood, M.P., in the chair. Evidence was given on behalf of the Manchester Chamber of Commerce as to the effect of marking imported goods intended for re-export with an indication of their origin, as to the probable influence on British trade in Eastern markets of the use of a National Trade mark on piece goods, and regarding the practice of folding textiles intended for the Far East in laps of less than a yard. The questions of the markings of foreign goods and the use of a National Trade mark were also dealt with by the National Union of Manufacturers and by the Perfumery Manufacturers and the Textile Trade Sections of the London Chamber of Commerce. From the Birmingham Assay Office came proposals relative to the Hall-marking of foreign plate and the protection of the British Hall- marks abroad. Suggestions for the marking of imported printed matter were made on behalf of the Postcard Publishers' Association, the Federation of Master Printers and Allied Trades, and the Joint Industrial Council of the Printing and Allied Trades.

THE price of bleaching powder in Japan has been subject to frequent fluctuations since last June. During June, July, and August the quotations were maintained at 5 80 yen, which went up to 7.30 yen in September, and after remaining the same throughout this and the following month, transactions ceased in November, and no standard price was quoted for that month. A sudden jump occurred in December, when the price abruptly rose to 18 yen, due to the limitation of output arranged by all manufacturers. Bleaching powder is not imported from abroad, but the entire local demand is supplied by the domestic manufacture and the surplus exported. If the manufacturers want to push up the price they can do so by restricting the amount of their output. The market price may be said to be entirely in the hands of manufac- turers. As a result of the advance in price the paper manufacturers, soap manufacturers, laundries, and other users of bleaching powder will naturally have to increase the price of their manufacture. It is expected that the industries affected will have to increase their prices in ratio to the increase effected by the manufacturers of bleaching powder.—*Reuter's Trade Service.*

## MEETINGS FOR THE WEEK.

*Monday, February 23.*

Royal Society of Arts, 8. (Cantor Lecture). "Recent Research in Cellulose Industry," by C. F. Cross, F.R.S.

*Tuesday, February 24.*

Royal Institution, 3. "Magnetic Susceptibility," by Prof. Ernest Wilson.

*Wednesday, February 25.*

Royal Society of Arts, 4 30. "Industrial Training," by J. Currie.

Geological Society, 5.30.

*Thursday, February 26.*

Royal Society, 4.30.

Royal Institution, 3. "Ancient Greek and Roman Life," by A. H. Smith.

Institution of Mining Engineers, 5. (Joint Meeting with the Röntgen Society and Royal Society of Medicine). "Efficiency of High Tension Transformers as used for X Ray Purposes," by Reginald Morton, M.D. "The Problem of Interrupted and Fluctuating Currents," by Major C. E. S Phillips, O.B.E. "High-tension Transformers," by R. S. Wright.

*Friday, February 27.*

Royal Institution, 9. "Problems of Lubrication," by W. B. Hardy.

Physical Society, 5.

Institute of Metals, 7.30. (At Sheffield). "Standard Silver—its Production and Working Properties," by E. A. Smith and H. Turner.

*Saturday, February 28.*

Royal Institution, 3. "Positive Rays," by Sir J. J. Thomson.

Chemist (Assistant Metallurgical) required in London Laboratory. With analytical experience in Ores and Metals and, preferably, with knowledge of Mineralogy.—State qualifications, experience, age, and salary required to C. A. M., care of Deacon's, Leadenhall Street, E.C.

Ex-Sapper, M.M., age 34, married, Grammar and Technical School education, Diplomas 1st class, Certificates in Inorganic Chemistry and Metallurgy, with thirteen years in steel works laboratory, including seven years apprenticeship, desires appointment as Assistant Metallurgical Chemist.—Address, Carter, 137, Bath Row, Birmingham.

Required, Assistant Chemists (18—20), London Inter. B.Sc. (preferably with Works experience of Tar Distilling).—Apply by letter to Messrs. Burt, Boulton, and Haywood, Ltd., Prince Regent's Wharf, Silvertown, E. 16.

Young Lady seeks Position in Analytical Laboratory. Good experience.—Address, Y. L., CHEMICAL NEWS Office, 16, Newcastle Street, Farringdon Street, London, E.C. 4.

Working Chemist required for old-established Oil and Paint Works in London. Must have had previous experience.—Write, stating age and suggested salary, to "F.," care of Abbott's, 32, Eastcheap, E.C 3.

Two Shillings and Sixpence is offered for one copy of No. 3064, Jan. 3, 1919, of the CHEMICAL NEWS.—Address, T. J. Drakeley, Northern Polytechnic Institute, Holloway, N. 7.

FOR SALE, unbound, "Journals of Society of Chemical Industry," 19.8, 19 9; Ramsay's "Gases of the Atmosphere"; Moore's "History of Chemistry"; Lake and Rastall's "Geology"; Scott's "Botany." Many other Books on Chemistry, Physics, &c. List from Fleet, Ivy Cottage Barnt Green, Birmingham.

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**DEVON COUNTY COUNCIL.**

The Agricultural Committee invite applica tions for the Post of ASSISTANT AGRICULTURA ANALYST AND LECTURER IN AGRICULTURA CHEMISTRY.

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'HE CHEMICAL NEWS

Vol. CXX., No. 3124.

# ARTIFICIAL NITROGENOUS FERTILISERS.

By E. J RUSSELL.

YNTHETIC nitrogenous fertilisers have been of interest to nemists ever since Sir William Crookes made his famous nnouncement to the British Association, in 1898, that the 'orld was faced with a serious food shortage unless it ould somehow increase its stores of fixed nitrogen. Sir Villiam indicated the solution of the problem, which nemists actively followed up. Synthetic fertilisers were roduced in quantity and tested by agriculturists in the eld. During the war the subject has been brought into igh prominence and great developments have occurred.

There are now three synthetic fertilisers available for griculture—ammonium nitrate, calcium nitrate, and yanamide. Of these ammonium nitrate is the most conentrated and probably also the most active, but it is also ie most expensive. At the termination of hostilities the elligerent Governments had large stocks on their hands hich were offered to farmers at low rates; in our own ountry the price was £25 per ton, packed in barrels. ılphate of ammonia was at the time being offered at 16 15s. per ton and nitrate of soda at £20 per ton. 'orked out as cost per unit of nitrogen (1 per cent per n—the unit in terms of which the farmer thinks) the ices were 14s. 4d. per unit for nitrogenous nitrate of nmonia, 16s. 9d. as sulphate of ammonia, and 25s. as trate of soda. Nitrate of ammonia was therefore much e cheapest, and there was no question as to its value to rmers at this price.

Events have shown, however, that £25 per ton is not economic price for nitrate of ammonia, and the supply this price is now exhausted; the Disposal Board is able to accept further orders from farmers. The iestion therefore arises, What price is the farmer justid in paying for nitrate of ammonia? Sulphate of amonia is obtainable at prices advancing from £21 per ton December to £22 per ton in March, April, and May; trate of soda will be offered next spring at £20—£22 per n according to locality. On the basis of equal unit price trate of ammonia should be offered at about £40—£41 r ton. Chemists have frequently inquired whether trate of ammonia has any value over and above that of e mixture of nitrate of soda and sulphate of ammonia to hich the unit system equates it. Numerous field exriments have been made; they indicate a slight lvantage but no marked superiority of nitrate of amonia over nitrate of soda and sulphate of ammonia when *mparison is made on the basis of equal nitrogen content.* cperiments are recorded by Hendrick in the *Journal of e Society of Chemical Industry* (1918, xxxvii., 146 R) on y, when nitrate of ammonia gave results up to 4 per cent tter than those obtained from nitrate of soda or sulphate of imonia. In the Newton Rigg experiments, on the other nd, the nitrate of ammonia was less effective than rate of soda; the results were:—

| | Yield per acre (tons). 1913. | 1914. |
|---|---|---|
| Nitrate of soda .. .. .. | $20\frac{3}{4}$ | $23\frac{3}{4}$ |
| Nitrate of ammonia .. .. | $14\frac{5}{8}$ | $21\frac{1}{2}$ |

*The low result of 1913 is difficult to understand and* ot typical of results usually obtained. The Rothamsted periments conducted during the season of 1918 with rate of ammonia supplied by the Ministry of Munitions ve the results shown in Tables.

Table I.—*Stackyard Field, Mangolds.* 1918.
(Seed sown May 29; roots carted December 9—12)

| Manure. | Weight of mangolds. Per plot (1/20 acre). Cwts. | qr | lb. | Per acre (mean of two plots). Tons. |
|---|---|---|---|---|
| Superphosphate, salt, and sulphate of ammonia .. .. .. .. .. | 19 | 1 | 8 | 18·6 |
| | 17 | 3 | 20 | |
| Superphosphate, salt, and nitrate of ammonia .. .. .. .. .. | 20 | 2 | 20 | 23·3 |
| | 25 | 3 | 18 | |
| Superphosphate and salt .. .. | 16 | 2 | 20 | 17·3 |
| | 17 | 3 | 16 | |

*Manuring.*

*All plots received a dressing of dung at the rate of 10* tons to the acre.

The other manures at rate of—

| | |
|---|---|
| Superphosphates .. .. | 4 cwts. per acre |
| Salt .. .. .. .. .. | 2 cwts. per acre |
| Sulphate of ammonia .. | 2 cwts. per acre |
| Nitrate of ammonia .. | 145 lbs. per acre (*a*) |

(*a*) Equivalent to 2 cwts. sulphate of ammonia.

Table II.—*West Barnfield, Potatoes.* 1918
(Variety "Arran Chief," planted May 9; 27 rows in each plot of 1/20 acre).

| Plot. | Manure. | Tubers roughly cleaned. Weight per acre. Cwts. | Mean per acre. Cwts. |
|---|---|---|---|
| 9 | Superphosphate and sulphate of ammonia .. .. .. .. .. | 175·4 | 175·4 |
| 11 | Superphosphate and nitrate of ammonia .. .. .. .. .. | 178·9 | 174·5 |
| 14 | | 170·0 | |
| 13 | Superphosphate alone .. .. | 146·8 | 160·9 |
| 10 | | 175·0 | |
| 15 | No artificials .. .. .. .. | 144·3 | 144·3 |

A dressing of dung was applied over the whole field in the winter, and ploughed December 10 to January 3.

Rates per acre of artificial manures:—

| | |
|---|---|
| Superphosphate .. .. .. | 4 cwts. |
| Sulphate of ammonia .. .. | 2 cwts. |
| Nitrate of ammonia .. .. | 145 lbs. |

On the other hand, nitrate of ammonia has some disadvantages in comparison with nitrate of soda; it is not so easily handled by the farmer; it has to be stored in casks, not in bags, and it is not readily applied by the ordinary drill. These are essentially minor disadvantages, but they off-set any slight advantage the nitrate of ammonia may possess over nitrate of soda, and probably no farmer would purchase it if he could obtain nitrate of soda at the same unit price. So long as nitrate of soda is obtainable at £20 per ton, farmers are not likely to purchase nitrate of ammonia unless it could be obtained at about £35 per ton, or less.

*Calcium Nitrate.*—This substance is now manufactured on a large scale, and is producible at prices comparable with that of nitrate of soda. Further, it is already fairly well known to agriculturists; it is in charge of a competent propagandist agent and is a really useful fertiliser. Experiments designed to compare it with nitrate of soda are recorded in the *Journal of the Society of Chemical Industry* (March 15, 1917, xxxvi., pp. 250–261; 1918, xxxvii., 146 R), and no important difference has been discovered. The percentage of nitrogen differs, nitrate of soda containing 15·5 per cent and nitrate of lime only 13 per cent, corresponding to 76·2 per cent pure calcium

nitrate, the rest being mainly water with traces of calcium oxide, carbonate, &c. This is in favour of nitrate of soda. On the other hand, nitrate of lime has the advantage that the calcium is never hurtful in the soil, while the sodium sometimes is, though also the sodium is sometimes an advantage. On the whole farmers would probably be willing to pay nearly as much per unit for nitrate of lime; and, assuming that nitrate of soda were available at £20 per ton, they would probably pay up to £16 or £16 10s. per ton, though of course they would purchase more freely at a lower price.

TABLE III.—*Little Hoos Field, Wheat.* 1918.

(Variety, "Red Standard" (after clover). Seed sown, November 3 to 5, 1917. Crop cut, August 12 and 13. 1918. Artificial manures applied, April 26, 1918 (by hand) consisting of 2 cwts. superphosphate per acre, 1 cwt. of sulphate of ammonia per acre, or 72½ lbs. nitrate of ammonia per acre (these contain equal quantities of nitrogen).

| | Dressed grain per acre. lb. | Dressed grain per acre. bush. | Straw per acre. lb. | Total produce per acre. lb. |
|---|---|---|---|---|
| Experiment I. | | | | |
| Unmanured .. .. .. | 2195 | 33 9 | 4030 | 6443 |
| Superphosphate only .. | 2492 | 38 6 | 4550 | 7310 |
| Sulphate of ammonia and superphosphate .. . | 2630 | 41·3 | 5250 | 8178 |
| Nitrate of ammonia and superphosphste .. .. | 2822 | 44 7 | 5070 | 8120 |
| Experiment II. | | | | |
| Unmanured .. .. .. | 2325 | 35·8 | 4450 | 7057 |
| Superphosphate only .. | 2198 | 34·6 | 4520 | 7025 |
| Sulphate of ammonia and superphosphate .. .. | 2585 | 40·1 | 4830 | 7775 |
| Nitrate of ammonia and superphosphate .. .. | 2400 | 37 7 | 5050 | 7830 |

*Cyanamide.*—Cyanamide presents the characteristic that it is not at once available for plants, but has to undergo change in the soil whereby ammonia is formed, which subsequently nitrifies. The whole value of the material therefore depends on the rate at which this change proceeds. In some soils it goes on rapidly, and here cyanamide is very effective. In others, however, it proceeds more slowly. It is a first essential that the change should be fully investigated, so that it can be fully understood; there is reason to suppose that the production of ammonia takes place in two stages, the first of which is purely chemical and the second bacterial; further, that the agent producing the chemical change is not always present in sufficient quantity in the soil. It would be an obvious advantage if a chemist could say beforehand of a given class of soil whether or not it were likely to decompose cyanamide. Work with this purpose has been carried out at Rothamsted, and the results are very promising.

The results of all published field trials show that the three fertilisers—nitrate of soda, sulphate of ammonia, and cyanamide—when compared on the basis of equal nitrogen content have the following values:—

| | |
|---|---|
| Nitric nitrogen .. .. .. .. | 100 |
| Ammoniacal nitrogen .. .. | 97 |
| Cyanamide nitrogen .. .. | 90 |

But these include cases where the cyanamide nitrogen could have had no proper chance of acting. Under better advice, such as is now obtainable, the farmer could have been warned beforehand, and the use of the cyanamide kept to those numerous cases where it can decompose rapidly and act well. In these circumstances the value of the cyanamide nitrogen might rise well above 90, and, what is more important, the risk of failure might be considerably reduced. Under present conditions farmers would be unlikely to pay more than about £18 or perhaps less per ton for cyanamide containing 20 per cent nitrogen if sulphate of ammonia were obtainable at £21. When the decomposition is better understood, however, experts will be in a position to advise more confidently; the fault lies less in the material than in our uncertain knowledge of some of the fundamental points.

On the other hand, the makers must obviate the presence in the commercial article of dicyanodiamide, which is actually harmful to vegetation. This is a factory problem, but chemists will not readily believe it to be insoluble.—*Journal of the Society of Chemical Industry*, xxxix., No. 1.

THE

## EXTRACTION AND PRODUCTION OF SUGAR FROM DIFFERENT VEGETABLE SOURCES.*

By ARTHUR R. LING.

### I. *The Carbohydrates as a Class.*

THE sugars, of which ordinary household sugar—the saccharose of the chemist—may be cited as a familiar example, belong to that group of compounds known as the carbohydrates, so named because their elementary composition is that of carbon combined with hydrogen and oxygen in the stoichiometric ratio in which these two elements are combined in water.

The mechanism of the formation of carbohydrates in green-leaved plants is on broad lines at all events better understood than perhaps any other physiological phenomenon in the economy of nature, whilst it involves a process of fundamental importance to the actual existence and continuance of all aërobic life. Green plants, as regards the formation of carbohydrates, are said to be autotrophic, that is to say, they do not depend on other organisms for making these compounds, but can form them from carbon dioxide resulting from combustion and respiratory processes occurring in nature.

Now, I want you to bear in mind that the net result of the metabolic changes associated with *all life* is exothermic in character, that is to say, heat is *evolved*, not *absorbed*. All organisms require heat for the production of energy and to maintain their body temperatures. We are here concerned with aërobic or oxygen-respiring organisms. By means of respiration, the particular organisms, whether animals or plants, are continually oxidising those portions of their tissues consisting of carbon and hydrogen to carbon dioxide and water. Respiration is, in fact, combustion at ordinary temperature, which living organisms are able to bring about.

(Anaërobic respiration which occurs in certain tissues of animals and plants is probably in all cases, so far as it applies to the carbohydrates, identical with alcoholic fermentation. The conversion of sugars into alcohol and carbon dioxide is on the whole an exothermic reaction. As regards the production of alcohol, it is a reducing reaction and endothermic, whilst as regards the production of carbon dioxide, it is one of oxidation, and exothermic).

I have dealt up to the present with the exothermic change called respiration, which is common to all living organisms, and so far as it concerns compounds containing carbon and hydrogen consists in the production of carbon dioxide and water. Both these well-known compounds are remarkably stable, and require the addition of an enormous quantity of energy to resolve them into their elementary constituents. Further, carbon dioxide when present in admixture with air in any considerable quantity produces, as you know, asphyxiation when such a mixture is inhaled.

Nature, has, however, provided a very simple means for its removal from the atmosphere, which not only restores

* From the *Journal of the Institute of Brewing*, February, 1920.

oxygen to the air, but provides plants with the carbohydrates—sugars, starch, cellulose, &c.—needed for ir development. The green colouring matter of leaves ıwn as chlorophyll in presence of bright sunlight is s to convert a mixture of carbon dioxide and water › carbohydrate and oxygen. Now, if we regard the bon dioxide and water formed by respiration as derived m a carbohydrate, we shall see that this is a reversible ction, and it can accordingly be expressed by the lowing equation:—

$$\text{[C]}H_2O + O_2 \underset{\longleftarrow \text{Photosynthesis endothermic} \longleftarrow}{\overset{\longrightarrow \text{Respiration exothermic} \longrightarrow}{\rightleftharpoons}} CO_2 + H_2O.$$

You will observe that the reaction, when it proceeds m left to right, is exothermic, *i.e.*, it is attended by the olution of heat, whilst, when it proceeds from right to ., it is endothermic, *i.e.*, it requires the addition of heat ergy. This heat energy is furnished by the sun's rays. e solar heat rendered latent, and the energy required to oduce a cereal crop on a given area of land, can be calated readily in thermal units or foot tons. The figures ınot but surprise the layman. In regard to the chanism of the absorption of carbon dioxide by the een leaves of plants, I would refer you to the recent ture delivered before the Chemical Society by Dr. orace T. Brown, in which he gives a full account of his earches on the subject with Mr. Escombe.

I have used the word photosynthesis in connection with endothermic reaction, and this, as you will be aware, notes synthesis by means of light.

Do not fall into the vulgar error which even now is to be ınd in the popular literature that animals respire oxygen, ereas green plants respire carbon dioxide. Green plants pire oxygen just the same as animals. Remember, as ave previously remarked, respiration is of necessity an othermic reaction.

In the equation given above, I have used the formula $H_2O$ as the simplest carbohydrate. This, or rather the bstance expressed by the formula $H.CH{:}O$, is formaldede, which has little in common with the higher members the carbohydrate group. There is, however, some idence that formaldehyde, or let us call it formose, is e first product of photosynthesis in the chlorophyll cells the green leaves. The first visible product of otosynthesis is one of the better known sugars. According to Brown and Morris it is saccharose. It appears most obable, however, that the simple compound $CH_2O$ is e first actual product of photosynthesis, and that is is condensed to ordinary dextrose, lævulose $H_2O)_6 = C_6H_{12}O_6$, &c., which is translocated as such the place of storage, the stem in the case of the sugar ne, the root in the case of the sugar beet, and the tuber the case of the potato.

Condensations of the hexoses to saccharose and starch spectively may be graphically expressed by the following uations:—

$$2C_6H_{12}O_6 - H_2O = C_{12}H_{22}O_{11}$$
(Dextrose or Lævulose). (Saccharose).

$$2(C_6H_{12}O_6)_n - (2H_2O)_n = (C_{12}H_{20}O_{10})_n.$$
(Dextrose or Lævulose). (Starch).

The fact that green plants acquire their carbon from rbonic acid was definitely established by Priestley in 1771, Ingenhouse in 1779, and by Senabier in 1788. A great lvance in a quantitative sense was made by de Saussure in 804, and by Boussingault in 1861, who showed that the olume of oxygen exhaled was equal to that of the rbon dioxide absorbed. In 1862, Sachs observed that arch is the first visible product of this photosynthesis; hilst, as we have seen, Brown and Morris in 1893 found at the first sugar which could be identified is saccharose, ıd this has been confirmed by numerous other observers. eyer in 1870 suggested, purely *ex hypothesi*, that rmaldehyde may be the first product of the synthesis, ıd in this connection it may be remarked that Butlerow 1861 had obtained in the laboratory a sugar-like ıbstance, to which he gave the name "methylenitan," by treating an aqueous solution of formaldehyde with certain bases. Usher and Priestley in 1906 stated that they had detected formaldehyde as a product of photosynthesis. They exposed green leaves, which had been killed by immersion in boiling water, to light, after which they were able to detect formaldehyde, and this observation, although criticised by some workers, has been confimed by Schryver.

Since the views that formaldehyde is the first product of photosynthesis was first advanced an an hypothesis by Beyer, numerous workers have attacked the problem. One of the difficulties is that since formaldehyde was known to be a protoplasmic poison, its existence, even admitting that the formation of sugars from it by a process of polymerisation occurred almost instantaneously, seemed unlikely. Bokorny, however, showed in 1891 that spirogyra, one of the green algæ, was rendered free from starch by being developed in nutritive solutions free from potassium salts and containing an excess of nitrates, carbon dioxide being rigorously excluded, the organism was killed by an aqueous solution of formaldehyde, but under the same conditions it flourished and formed starch when supplied with the compound of formaldehyde and monosodium sulphite.

From the standpoint of the physiologist it would appear that it is scarcely necessary to assume the formation of the simplest fixed statical compound such as formaldehyde, as a product of photosynthesis. Whilst the chemist sees a difficulty in admitting the direct formation of complex substances such as saccharose and starch, to the physiologist this presents no difficulty at all, for his view is that stated by the ancients, πάντα ῥεῖ, everything is in a state of flux.

There are more resting forms of carbohydrates than saccharose and starch, but these will serve as illustrations. I should like to point out that dextrose and lævulose (the constituents of invert sugar) and maltose (the main sugar of sweet wort), substances with which you are all familiar, are sugars possessing the group C : O (carbonyl) in their molecule. In virtue of this they react with phenylhydrazine, and also reduce alkaline copper solutions. In a *physiological sense they may be regarded* as dynamical compounds as distinct from the non-reducing carbohydrates cane-sugar and starch, which physiologically considered are statical compounds.

*I shall be told in this connection that in barley*, wheat, sugar-cane, &c., there is always present a certain minute quantity of reducing sugar. This, in my opinion, is largely fortuitous. It may be due to the fact that the *conversion of reducing sugars into saccharose or starch is* a balanced reaction, or it may be due to the rupture of certain cells liberating enzymes which hydrolyse the saccharose or starch into reducing sugar. Then the fact may be *cited as opposed to my thesis, that during the* ripening of fruits the quantity of reducing sugar is continuously augmenting. This latter case is not a true parallel, for ripening is a dynamic and not a static or *resting process. Ripening, in other words, may be regarded* as analogous to germination.

The metabolism of the better known carbohydrates can very well be illustrated by a study of the germination of a barley corn, *and to this subject I will now direct your* attention.

In its resting stage a grain of barley contains an enzyme capable of converting starch or a certain form of it into reducing sugar, *but in the resting corn this enzyme* remains inoperative. As soon as germination is initiated this enzyme becomes modified, and others appear to be secreted which act on the cell walls of the endosperm containing starch *granules, so that they become permeable* to electrolytes and other substances besides water. Operating *in vitro* we know that under these circumstances we should obtain maltose as one of the products, what we obtain as initial product *in situ* is not known, but we may assume with a fair amount of certainty that it is some- reducing sugar. As soon as this reducing sugar is formed

t is translocated through the epithelial cells to the scutellum, where that quantity not taken up by the germ is stored as starch and saccharose. The reducing sugar which is also found in germinating barley seems to consist principally of invert sugar resulting from the hydrolysis of saccharose; there is no evidence of the presence of maltose in germinating barley. As germination continues, more cells become attacked and ultimately the reducing sugars wander or are translocated to the embryo and to the aleurone layer. In the embryo that portion not needed by the germ is as we have seen transformed into starch and saccharose, whilst in the aleurone layer the reducing sugar which reaches this portion of the corn is stored as saccharose; starch is never found in the aleurone cells. I mention these facts to illustrate to you how easily the ordinary carbohydrates with which you are all familiar are interchangeable in nature. The problem is vastly different in the laboratory. It was one of the great aims of the late Prof. Emil Fischer to synthesise saccharose, yet this was never achieved.

As I have already pointed out, sugar is very widely disseminated in the vegetable kingdom, representing as it does in many plants the most important carbohydrate reserve substance. Originally consumed as a condiment, or even as a medicine, it has become during the last few centuries one of the most important articles of dietary among civilised nations. The United Kingdom, which next to the United States is the largest sugar-consuming country in the world, consumes sugar in different forms at the rate of more than 90 lb. per capita per annum.

### *Sugar Cane.*

The chief sources of supply of sugar are the sugar cane, *Saccharum officinarum*, one of the Gramineæ or grasses, and the sugar beet, *Beta vulgaris*. Among other plants of less importance as sources of sugar supply may be mentioned certain species of palm, as well as the maple and the sorghum.

The earliest recorded production of sugar is from the sugar cane in India, to which country many writers believe the sugar cane to be indigenous. Others have pointed out, however, that one kind of cane found in Java is a species, and not a variety, of the native Indian cane, so that it may have been indigenous to more than one part of the East.

In the *Antharva Veda*, one of the sacred books of the Hindus, mention is made of sugar cane, whilst writers at the time of Alexander the Great refer to a reed growing in India which produces honey without the aid of bees. In the early centuries of the Christian era sugar production (from cane) was carried on in Persia and Egypt, and at the time of the Crusades extensive sugar plantations existed in Tripoli, Mesopotamia, Palestine, Syria, &c. In 1150 Spain had a flourishing sugar industry, and 75,000 acres of land was cultivated with sugar cane.

The Arabs and Chinese introduced the sugar cane into Tunis, Morocco, Gambia, Madagascar, Siam, Sunda Islands, the Philippines, Formosa, and Japan. After Constantinople was taken by the Turks in 1453, much of the prosperity of the sugar industry in the Near East and the Mediterranean came to an end. In the fifteenth century the Portuguese established a sugar industry in Madeira, Azores, Cape de Verde Islands, &c., whilst towards the close of the same century the Spanish commenced sugar cultivation in the Canary Islands.

After the discovery of America, the sugar cane was introduced into the various parts of the islands and mainland suitable for its production. It is stated that the sugar cane was introduced into the West Indies in 1493 on the second voyage of Columbus. The pioneers were the Spanish, Portuguese, Dutch, and later the English and French. Sugar cane is now cultivated in the tropical and sub-tropical parts of Asia, Africa, America, and Polynesia. In Europe, Spain is the only country which cultivates cane, and sugar to the extent of between 6000 and 7000 tons is now manufactured from it annually in country.

The sugar cane is grown from cuttings, and the p attains maturity at the end of 15—18 months, when cut and dealt with in the factory. The stubble is le the ground, and ultimately produces shoots, called rato These are in turn cut, and produce second ratoons, so on. The ratoon crop is not so rich in sugar as original cane. However, fresh cuttings are only pla in periods of from 2—7 or more years, according to richness of the soil. There are places in the worl which no fresh cuttings have been planted for more t fifty years, the crop depending entirely on ratoon These are instances in which virgin oil exists, and are and far between.

Much work is now being done in attempting to imp the cane by growing it from seeds produced by cross tilising different varieties. Here difficulties are countered, for some varieties do not flower at all, wl in others the pollen of the anthers is found to be infer However, success has attended these experiment different parts of the world, and it has been fo possible in many instances to breed cane suitable t given locality.

The sugar cane, as now cultivated, under the n favourable conditions, gives a crop of 30—40 tons acre, and sometimes more, and has a sugar-conten 11—16 per cent. Taking a yield of cane of 35 tons acre, and an extraction of sugar of 12 per cent, this wc mean a production of sugar of 4·2 tons per acre. have heard of as much as 7½ tons per acre having b obtained in isolated instances.

### *Sugar Beet.*

The history of beetroot sugar dates from 1747, w Marggraf, a German chemist, demonstrated the possib of extracting sugar from beet. Some fifty years lat Frenchman, named Archard, who was a refugee in ( many, continued this work, and at the commencemen the nineteenth century the first beet sugar factory started in Silesia. It had a capacity for dealing v about 500 tons of roots per annum, which might b produced 25—30 tons of sugar. The industry was foste by Napoleon the First, who thought thereby to crip England's colonial sugar trade. In 1811 he orde 80 000 acres to be planted with beet. The industry flag somewhat after the wars, but it was taken up by Germ as well as by France, and in 1860 the production of b sugar was 250,000 tons. In 1871 France produced 284, tons and Germany 186,000 tons of sugar, whilst in 1 the German production reached 1,000 000 tons, whilst French production had dropped to 265,000 tons.

Coming to more recent times, in 1913, the world's p duction of beetroot sugar was 8,758,900 tons, or 46 96 cent of the total sugar production from cane and b together. Of this, Germany produced 2,718 000 to The cane production at the same time was 9,894,200 to The remarkable success met with in Germany in impr ing the sugar-content of the roots by selection manuring may be judged by the fact that at the co mencement of the industry the roots probably contai not more than 6—8 per cent of sugar, whilst the sug content had steadily improved until the roots of the 1 harvest contained an average of 17 63 per cent of sug Of this over 90 per cent would be secured by mod methods.

It will be seen that the sugar-content of beets is hig than that of cane, but the crop is a lighter one. On average under the best conditions, about 12 tons of be can be grown to the acre, so that the yield of su seldom reaches 2 tons per acre, and is generally a li below it.

The late Mr. George Martineau in his booklet *Sug Cane and Beet*, p. 17, makes the following pertin remarks on the comparative yields of sugar from c and beet:—

[I]t is curious to think that this humble root" (the beet) [wei]ghing only 2 lbs. should now be giving to the world [as mu]ch sugar every year as the lordly sugar cane, and [that] the beetroot factory should actually extract a greater [perce]ntage of sugar from the little root than the cane [factor]y wins from the rich cane. But it must not be for[gotte]n that, under favourable conditions, the cane can [produ]ce twice as much sugar to the acre as the beetroot. [Whic]h will win the race?"

[Th]e British Empire, according to the last returns, had [abou]t 3,500,000 acres under sugar, mostly cane, yet the production from this was less than that of Germany [and A]ustria-Hungary combined, which countries could not [have] had so much as half that number of acres under [cane]. Obviously, in view of what has been stated as to the [poten]tialities of sugar production from cane and beet [respe]ctively, there must be something wrong with our [meth]ods.

[Le]t us bear in mind that the British Empire exceeds all [other] States in the production of sugar, and the United [King]dom occupies the second place, coming next to the [Unit]ed States, as an importer of sugar. It is of particular [signi]ficance in connection with this last named fact that [prior] to the war more than 96 per cent of the sugar im[porte]d into the United Kingdom came from foreign [coun]tries, and by far the greater portion of the imported [suga]r (80 per cent) was European beet sugar. In fact, [befor]e the war the importation of raw cane sugar was [restr]icted to the demands of those industries like brewing [whic]h found raw beet sugar unsuitable for their require[men]ts.

[As] regards the consumption of sugar per capita per [annu]m of the important countries before the war, the [Unit]ed Kingdom comes first with 95 lbs., whilst the United [Stat]es is second on the list with 89 lbs., Germany 49 lbs., [and] France 48 lbs.

[Fo]llowing the outbreak of hostilities the production of [suga]r from beet had dropped from 47 per cent to 29 per [cent] of the world's total supply. On the other hand, the [prod]uction of the British Empire had increased 3,275,500 [tons] in 1913—14 to 4 394,100 tons in 1917—18 (or 34·1 [per c]ent), whilst the total production of sugar throughout [the w]orld, which was 18,653,100 tons in 1913-14, was in [1917]—18 17,556,400 tons. The countries showing the [great]est increases are India, Cuba, and Java.

[Th]ere is no doubt that the importance of the race now [bein]g run is fully recognised in all parts of the British [Emp]ire, and the granting of Imperial Preference should [help] our sugar industry, but it must not be forgotten that such measures without efforts on the technical side [will] be unavailing. It is well to insist on this point and [to in]dicate where, and in what directions, reforms and im[prov]ements are most needed. Let us not forget, how[ever], that time presses. Our late enemies are eagerly [watc]hing all we are doing, and unless we make the neces[sary] improvements within the next year or two we shall [the]n be left behind in the race for supremacy.

(To be continued).

## CYANOGEN CHLORIDE.

### [I]TS PREPARATION ON A LARGE LABORATORY SCALE.

[At] a meeting on Thursday, February 12, at the University [of B]irmingham, under the auspices of the Birmingham [and] Midland Section of the Society of Chemical Industry, [a p]aper on "*The Preparation of Cyanogen Chloride on a [Lar]ge Laboratory Scale*" was submitted by Dr. T. SLATER [PRI]CE, O.B.E., and Mr. STANLEY J. GREEN, M.A., F.I.C. [T]he Chair was occupied by Dr. H. W. BROWNSDON [(Kin]ga Norton Metal Works), and there was a large [atte]ndance of works chemists and engineers.

[T]he preparation of cyanogen chloride, the authors ob[serv]ed, seems generally only to have been carried out on a small laboratory scale, but early in 1918 the necessity arose of making large quantities of this substance for special experimental purposes. The Admiralty had given permission to publish a record of work on cyanogen chloride carried out under the authors' direction at the Royal Naval Experimental Station, Stratford, E., during the war. Examination of the literature on the subject indicated, they point out, that there were three methods which might be feasible, namely, the action of chlorine upon (*a*) hydrocyanic acid, (*b*) sodium cyanide, or (*c*) the complex cyanide of sodium and zinc. It was ultimately found that the best method of preparation was by the action of chlorine on a dilute solution of hydrocyanic acid. The action of chlorine on a solution of sodium cyanide was first suggested by Langlois, the reaction taking place according to the equation $NaCN + Cl_2 = NaCl + CNCl$. Considerable heat is evolved during the reaction, and unless care is taken to keep the temperature down by adequate cooling the solution soon darkens in colour; even when cooled with ice a brown coloration appears. When this reaction was carried out on a larger scale, using about 10 litres of sodium cyanide solution, it was found that darkening always took place, although the conditions of experiment were varied with respect to concentration of solution, rate of passage of chlorine, cooling, &c. In all cases very little cyanogen chloride was produced, and ultimately this method of preparation was abandoned. Regarding the action of chlorine on the complex cyanide of zinc, it is pointed out that this method was first suggested by Held in 1897, the idea being that the addition of zinc sulphate to a solution of potassium cyanide made the solution more stable to the action of chlorine. In the authors' experiments, sodium cyanide was used in place of potassium cyanide, the quantities of sodium cyanide and zinc sulphate taken being such that the compound $2NaCN,Zn(CN)_2$ or $Na_2Zn(CN)_4$ was formed. In come cases the mixture was such that a slight excess of zinc cyanide remained in suspension, the purpose of this being to ensure a non-alkaline reaction mixture. The volume of the solution used was about 8 litres, containing 90 grms. of crystallised zinc sulphate and the corresponding quantity of sodium cyanide. The temperature was maintained at approximately 0°. In all cases the rate of chlorination was very slow. As cyanogen chloride is formed, zinc cyanide is precipitated gradually, to dissolve again as it is decomposed with the formation of more cyanogen chloride. The method gave fairly good results, but in view of the fact that it seemed to be much less economical and convenient than the one, in relation to the action of chlorine on a dilute solution of hydrocyanic acid, the experiments were not continued. Moreover, in several instances the reaction mixture darkened during chlorination.

The first preparation of cyanogen chloride dated from 1787 by Berthollet by the interaction of chlorine and hydrocyanic acid. The method has since been the subject of many investigations. The use of anhydrous hydrocyanic acid is impracticable. During the reaction hydrogen chloride is formed in accordance with the equation $HCN + Cl_2 = HCl + CNCl$. The amount evolved is not evolved to the volume of the chlorine passed in, since a large part of it combines with the anhydrous hydrocyanic acid, probably giving chloroformimide, $Cl.C(:NH)H$. Moreover, cyanogen chloride formed is likely to be rapidly polymerised to cyanuric chloride by the action of the anhydrous hydrogen chloride. The heat of reaction was so great as the temperature rises rapidly. Experiments made on the effect of varying strengths of aqueous hydrochloric acid on the rate of polymerisation of cyanogen chloride showed that a comparatively weak acid, about 2—5-normal, had very little polymerising effect. After a number of different experiments it was decided to employ a strength of hydrocyanic acid solution, such that at the end of the reaction the concentration of the hydrochloric acid formed is sufficiently below the saturation point to prevent much hydrogen chloride gas

assing off. 20 per cent hydrocyanic acid is too strong to satisfy this condition, whereas 12—15 per cent strength was found to be fairly satisfactory. The reaction vessel *was not cooled*, but the heat of reaction was utilised to distil off the cyanogen chloride as it was formed, so that it was quickly removed from the action of the hydrochloric acid set free at the same time. The heat of reaction was considerable. Some difficulty was found at first in devising a method for the introduction of chlorine into the solution, so that it would enter into complete reaction before it reached the surface of the liquid. Ultimately it was found that this object could be attained by driving it in under considerable pressure through a Berk patent spray nozzle, but this method was improved on by the use of porous pots. Porous pot water filters, suitably bunged and strengthened, and connected by glass tubing with the source of chlorine, were placed in the hydrocyanic acid solution, and chlorine forced through under the pressure from a cylinder of liquid chlorine. The chlorine escaped in very fine bubbles, and chlorination was extremely rapid. The results of experiments indicate that during the chlorination of 12—15 per cent HCN, cyanogen chloride is formed quantitatively according to the equation given. A rise in temperature up to 40° does not diminish the amount produced; it does, however, lead to the distillation of much larger quantities of hydrogen cyanide, with a consequently higher content of HCN in the cyanogen chloride obtained. The hydrochloric acid formed during the reaction is retained almost completely in the reaction vessel. In an experiment where 30 per cent solutions of sodium cyanide and sulphuric acid were mixed, giving a 9 per cent solution of hydrocyanic acid, the yield was only 70 per cent of the theory, and larger quantities of ammonium chloride were formed. Three methods were actually used for purifying the cyanogen chloride, according to the purpose for which it was to be used. (1) Chemically pure cyanogen chloride was made on a small laboratory scale by taking the crude substance, containing hydrogen cyanide, traces of hydrogen chloride, and water, well cooling and saturating with chlorine. The product was then shaken with mercury to remove traces of chlorine, sodium carbonate, or sodium hydrogen carbonate, to remove hydrogen chloride, and then drying over calcium chloride and distilling. (2) A product containing 96—99 per cent CNCl was obtained by passing chlorine through a series of Winchester bottles containing 80—90 per cent CNCl and a good excess of water, the cyanogen chloride thereby distilling in a current of chlorine. (3) Shaking with zinc oxide was the practice when 99—100 per cent CNCl was required. Prolonged shaking with zinc oxide and water reduces the hydrogen cyanide content to 0·05 per cent, and the product so obtained is then dried and distilled. Yellow mercuric oxide is also very convenient for removing even larger percentages of hydrogen cyanide.

The question may arise, the authors add, as to whether in the large scale preparation (or manufacture) of cyanogen chloride it would be better to make the hydrocyanic acid *in situ*, or first prepare the pure aqueous solution. In the one method tried the solutions of sodium cyanide and hydrochloric or sulphuric acid used have to be well cooled before mixing, and extensive refrigeration must also take place during the reaction in order to prevent the hydrogen cyanide escaping. According to the second method experience in the manufacture of anhydrous hydrogen cyanide, which has a b.p. 20°, shows that a brine-cooled condenser is only necessary to condense the last traces of vapour, the greater part being condensable in a water-cooled condenser. The demands on a refrigerating plant are therefore small.

The pure product was a colourless liquid boiling sharply at 13°. The freezing-point was −8°. On pouring the liquid from one vessel to another it froze readily to a snow-like solid. Investigation of the action of hydrogen chloride on cyanogen chloride shows that the latter is polymerised to cyanuric chloride and hydroxylation to cyanic acid and carbon dioxide, and hence to ammoniu[m] chloride and carbon dioxide. It was not found that d[ry] chlorine has any polymerising effect on cyanogen chlorid[e]. With moist chlorine there is a slow action, but no polym[er] is formed. Pure anhydrous phosgene and cyanoge[n] chloride have no action on each other; but in the presen[ce] of moisture, however, both ammonium chloride an[d] cyanuric chloride are formed.

## BOARD OF TRADE ANNOUNCEMENT.

### The Non-ferrous Mining Committee.

The Committee appointed by the Board of Trade, und[er] the chairmanship of Mr. H. B. Betterton, M.P., to inqui[re] into Non-ferrous Mining in the United Kingdom have no[w] completed the taking of evidence, and are preparing [a] report which they hope to present in a few weeks time.

With regard to evidence taken, Col. J. V. Ramsden, r[e]presenting the Barytes Producers Association and th[e] Shropshire Mines, Ltd., described the steps now bein[g] taken to improve the grinding and grading of barytes, an[d] stated that protection against the importation of foreig[n] barytes at low prices was necessary if the industry was t[o] be preserved.

Mr. Anthony Wilson, of the Thornthwaite Mines, Ltd[.] gave evidence respecting the lead and zinc mines in th[e] Lake Districts, and referred to the need for allowances fo[r] depreciation of plant and amortisation of buildings an[d] shafts in the assessment of mines for income tax.

Mr. W. H. Borlase explained the present position an[d] future prospects of the Greenside Mine in Patterdale, an[d] Mr. J. Cox described the operations of the Vieill[e] Montagne Zinc Company at Nentbead.

Mr. J. Mitchell, Manager of the Wanlockhead Lea[d] Mining Company, explained his proposal for draining th[e] Lead Hills district by means of a deep level gravitatio[n] tunnel, and Mr. F. F. Wilson and Mr. Bawden Skewi[s] of the Lead Hills Company, discussed the attitude [of] their company towards participation in such a scheme.

Mr. C. Petts described the operations of the Mill Clo[se] Mine in Derbyshire, and Mr. H. Seed gave evidence i[n] regard to the Ashover Mines in the same county. Th[e] latter are now worked almost entirely for fluorspar, f[or] which there is a good demand for use as a flux in met[al]lurgical operations. Prof. H. Louis gave evidence wi[th] regard to mining in Northumberland, Durham, and Yo[rk]shire, and suggested that a trial of the Melmerby S[car] limestone offered the best chance for a resuscitation [of] lead mining of that district. He thought that the [im]portant effect which a successful issue to this trial w[ould] have, justified the expenditure of national funds on it.

Mr. P. E. Marmion, of the Swansea Vale Spelter C[om]pany, gave evidence regarding the properties and val[ue] of British blendes from the spelter maker's point of vie[w] and discussed the sources from which the spelter make[rs] obtained their ores.

Mr. N. Reynoldson stated the present position an[d] prospects of the Cabbish and Lunehead Mines in West[]moreland.

Mr. G. W. Lamplugh explained the nature of the wor[k] normally undertaken by the Geological Survey and th[e] special duties in an economic direction undertaken by them during the war, and Mr. Ll. S. Lloyd, of the Depart[]ment of Scientific and Industrial Research, gave evidenc[e] respecting the relationship of that department to th[e] Geological Survey.

Mr. T. W. Ward discussed the effect of the war on th[e] operations of the Esgairmwyn mine, and evidence on th[e] labour side of the enquiry was given by Mr. John Camero[n] and Mr. W. Latham, of the Miners' Federation; Mr. T[.] Morgan and Mr. W. Morgan, of the National Amalga[]mated Labourers Union; Mr. W. Sherwood, Mr. J. W[.] Hogarth, and Mr. J. W. Shield, of the National Unio[n]

General Workers; and by Mr. E. Barclay, Mr. A. ighes, and Mr. H. Thomas, of the Dock, Wharf, Riverle, and General Workers Union.

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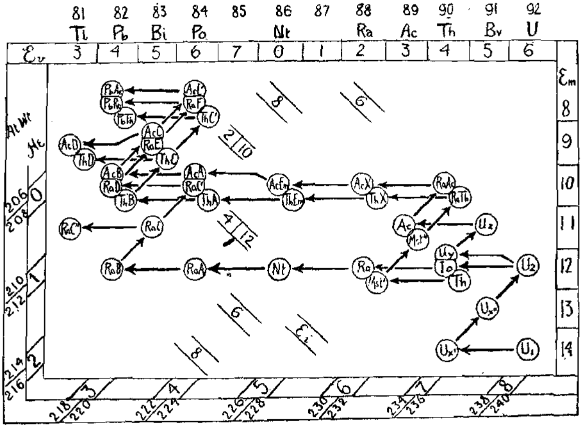
## TABLE OF THE RADIO-ACTIVE ELEMENTS WHICH INDICATES THEIR STRUCTURE.

By INGO W. C. HACKH, Professor of Chemistry, College of Physicians and Surgeons of San Francisco, Cal., U.S.A.

ɴ a recent paper on the "Conception of a Chemical lement as Enlarged by the Study of Radio-active hange," Prof. F. Soddy has given a masterly summary f *the present status of our knowledge concerning the* adio-active elements (*Journ. Chem. Soc.*, 1919, cxv., 1). From a study of the phenomena of disintegration in connection with the new Periodic Table (*Journ. Am. Chem. Soc.*, 1918, xi., 1023; *Am. Journ. Sci.*, 1918, xlvi., 481; *Astrophys. Journ.*, 1918, xlviii., 241), it becomes possible o ascribe a partial atom-structural formula to each of the thorium. The difference in the structure formulæ of the first and last members is therefore in the uranium series 8He and 6E, indicating eight alpha- and six beta-changes, while in the thorium series the difference is 6He and 4E, indicating six alpha- and four beta-changes.

*The relationship among the members of the uranium-*radium, uranium-actinium, and thorium series is shown in Fig. 1, in which the branching off of the actinum series is according to Soddy (*loc. cit.*). From the figure can be derived the partial structural formula of each of the radio-active *isotopes. Thus the number of helium particles* (and also the atomic weight) is the same for each isotope lying on the same south-west to north-east axis; the number of electrons in the unstable next inner ring ($E_i$) is the same for each member on the same north-west to south-east axis; the number of valency electrons ($E_v$) are shown on the north to south axis, and the total "metastasic" electrons ($E_m = E_i + E_v$) are the same for each substance on the same east to west axis. In the partial atom-structural formula the nucleus *u* for unanium nucleus with atomic weight 206 4, and *t* for thorium nucleus of atomic weight 208 2, contains the unknown

Fig. 1




lio-active elements (*Phys. Rev.*, 1919, xiii., 165). Thus ias been shown that the emission of a helium particle pha-radiation) is accompanied by the shift of two "metastasic" electrons from the outer or valency ring nto the *next inner and unstable ring, while the emission* of an electron (beta-radiation) is accompanied by the shift of one "metastasic" electron from the next inner and instable ring to the outer or valency ring. In the calculation of the partial atom-structural formulæ the changes between the first and last member of each series have been utilised, for this difference furnishes a tangible basis of he structural composition of the respective atom.

Assuming that each transformation is caused by the emission of *one* helium partial resp. *one* electron from *one* atom, the atom-structural formula for uranium 1 is $u\,.\,He_8E_{8+6}$ and for thorium $t\,.\,He_6E_{8+4}$, while the last members of each series have a structure formula of $u\,.\,E_{4+4}$ *for lead from uranium and* $t\,.\,E_{4+4}$ *for lead from* thorium number of helium nuclei and electrons, and indicate respectively lead from uranium and lead from thorium. To this nucleus are added the number of He, $E_i$, and $E_v$ which constitute then the partial atom-structural formula. Thus, *e.g.*, *the four isotopes of element with atomic* number 88 are as follows:—

$AcX = u\,.\,He_4E_{8+2}$ with an at. wt. of $u + 4He = 222\cdot4$
$ThX = t\,.\,He_4E_{8+2}$ with an at. wt. of $t + 4He = 224\cdot2$
$Ra = u\,.\,He_5E_{10+2}$ with an at. wt. of $u + 5He = 226\cdot4$
$Msth = t\,.\,He_5E_{10+2}$ with an at. wt. of $t + 5He = 228\cdot2$

As has been pointed out previously (*Phys. Rev.*, *loc. cit.*) this partial atom-structural formula indicates—

(*a*) The series to which the isotope belongs by resp. *t*;
(*b*) the atomic weight, by the addition of the number He (4·00) to *u* resp. *t*;

(*c*) the valency, by the number of valency electrons ($E_v$) written at the end ;

(*d*) the number of metastasic electrons ($E_m$), by simply adding the inner and valency electrons together.

The relationship of this system of radio-active elements to the periodic system is established by attaching Fig. 1 to the lower part of the new Periodic Table (*loc. cit.*). Whether or not it is possible to extend this scheme of isotopes to the non-radio-active elements is a problem of the future.—*Philosophical Magazine*, January, 1920.

## NATIONAL CONFERENCE OF MANUFACTURERS AND PRODUCERS.

### President's Address.

On behalf of the Federation of British Industries I extend a cordial greeting to this important gathering of British Manufacturers and Producers. I believe this is the first occasion of a widely representative Congress of this character.

It has been suggested that it would be most desirable that manufacturers, representing all shades of interests, should meet together at least once a year for the purpose of discussing important national problems which are continually arising, from their point of view. After all, it is a trite saying that a country exists upon its productions. We cannot live by taking in one another's washing, and important from a social point of view as may be all other of the Nation's activities, it cannot be denied that the ability to support its population depends upon the volume of its productions.

Unfortunately the aspect of private gain, which so far as our experience goes at present appears to be the only conceivable and efficient mainspring of production, raises questions of personal interest and class prejudices, which obscure and confuse the issue. It is sometimes suggested that manufacturers are apt to be influenced in their opinions more by considerations of their private rather than the national advantage. In the past there has perhaps been some justification for this view, but I am not without hope that the recent developments in the direction of Trade Organisation have done much to modify this tendency. The closer and more intimate relationship which has existed of late between members of various trades amongst themselves and among their representatives in the general Councils of such bodies as the Federation of British Industries, and the Associated Chambers of Commerce, has done much to raise their discussions to a higher National plane, and that spirit of selfishness which is inevitably developed under the old system of purely individualistic effort has been greatly modified. I believe this tendency will be assisted by the Congress which we are holding to-day, and I hope the character of our discussions on the many important national problems which will be submitted for our consideration will effectively rebut the charge of selfishness, and will make it clear that the producers of this country have a due sense of their responsibilities.

Never, I suppose, in the history of the world has the social and economic position presented such complexities as at the present time. Under normal conditions, such as we experienced prior to the war, the long working of economic laws produced an economic equilibrium to which we were so accustomed that it ceased to be a matter for wonder. The great financial upheaval resulting from the war, aggravated by the enormous increase of credits, particularly among the belligerent nations, has so disturbed the equilibrium as to give the impression that those laws have ceased to be effective.

Certain portions of the world are enjoying exceptional material prosperity ; other parts of the world, not less important from an industrial and productive point of view.

are practically bankrupt. They are depleted of essen
stocks, heavily in debt to the rest of the world, and
some cases burdened (deservedly, no doubt) with h
indemnity obligations, while their position is being d
made worse and worse by the fact that they are, q
inevitably, consuming more than they produce. Un
normal conditions, the economic law itself tends to rest
equilibrium. At the present time it would appear to
impossible to achieve this in the case of the Contin
without the adoption of extraordinary artificial mea
The adverse exchange position of the impoveris
countries should automatically foster their export tra
and conversely hinder that of their creditors. Now
debtor countries are so crippled that they can
export.

It is not necessary to dwell in detail upon the dread
position of Russia and the Balkan States, and for
purpose of illustration we might with advantage conf
our thoughts to the countries of Germany, the Uni
States, and Great Britain, as illustrative of th
typical conditions.

Germany seems to offer an extreme case of the result
a country of consuming more than it produces. T
effect of the creation of excessive credit, coupled w
the absence of any material production for export, h
been the extravagant inflation of prices and the depre
ation of the Mark almost to zero. As an illustrati
the last price advised of pig-iron is 1700 Marks per ton,
compared with the pre-war price of about 80 Marks
ton. These extravagant prices, together with the deplet
of essential raw materials obtained from abroad, up
which the industry of Germany is dependent, and
depreciated rate of exchange, would seem to make
impossible for German industry to make a fresh sta
There appear to be only two alternative solutions ; Natio
bankruptcy, that is to say, a national social upheaval a
starting absolutely afresh, is one painful solution,
solution which would seem to be imposed by the ordin
operation of economic laws ; the other alternative see
to be the intervention of artificial assistance pr vided
human ingenuity. The danger of adopting the la
course is the danger lest the remedy be in the nature
sticking-plaster—a temporary relief hiding, rather th
curing, the disease. Moreover, it is not surprising th
we in this country view any proposals for the assistan
of Germany with considerable suspicion, if not with d
favour. We are not unmindful of the past record
Germany, and the danger that if Germany is rehabilitat
she may insidiously work out a policy directed u
mately to revenge, and we may perhaps be pardoned
we view such a possibility with some apprehensi
with our knowledge of the German capacity for pati
organisation. We feel this so strongly, that it mi
be thought a financial and social cataclysm in Germa
would leave us cold. Many would say that Germa
was only reaping a due and proper punishment for h
crimes upon humanity. There are, however, two co
siderations, founded upon our own interest, which t
heavily on the other side. In the first place, the All
rightly expect some indemnity from Germany to pay t
cost and injury of the war. This indemnity she can
the long run only pay by export of goods. She m
therefore be put in a position to produce. In the seco
place, a social and economic catastrophe in Germa
might be far-reaching in its consequences. The spre
of Bolshevism in Russia is already in the nature of
universal peril, and already emissaries of Bolshevism a
seeking to spread their doctrines insidiously through
the world. A financial cataclysm in Germany, follow
by social revolution and wide-spread distress, co
hardly fail to exaggerate these dangers. The mi
shudders at the thought of the economic and soc
downfall of a Nation so advanced on the road to civ
isation as Germany. The consequent evils could n
fail to extend over its borders, and as the ripples spre
when a stone is thrown into the water, so would there

e-percussion of the disaster throughout the civilised rld.

Ve here may be well satisfied that Bolshevism will er gain a hold over our own country; we have too ch confidence in the native good sense of our own ople, their high level of education and pride in our :ient institutions, and in the readiness with which our itical organisation responds to any reasonable grievance. t other countries are not so happily placed, and we d interests in parts of the world where stability would much more easily endangered. With these possible isequences of the first alternative policy in view, eminent ikers have addressed their minds to the second al er- .ive which I have mentioned, including our own eemed Past-President, Sir R. V. Vassar-Smith, and ne of their conclusions are embodied in a resolution ich will be presented for your consideration. Broadly :aking, it is suggested that arrangements should be ide for the supply to the Continental powers requiring ip, of certain necessary raw materials, essential to the iabilitation of their industry. The question is an .remely delicate one, as not only is it manifest that any dit which this, or other countries, can be asked to ex- id for this purpose must be strictly confined to the ject aimed at, but it is no less important that careful ivision should be made to ensure that the remedy shall of real effect. Germany, then, is a country in the sition of a spendthrift who has pledged his credit to the t, and has so consumed his resources that be lacks erything that is necessary to make a fresh start.

Different indeed is the case of the United States. In : United States there is neither serious inflation of credit r of currency. Her position differs but little from the rmal, except possibly in the extent to which she enjoys undless prosperity. That prosperity is largely the result her huge exports of war and other material during the st few years. In passing, it may be noted that in spite of : great advance in prices her imports during the last two ars have only doubled in value over the pre-war, while the lue of her exports have increased nearly fourfold. Is it rprising that the exchange has moved so heavily in r favour? During the war equilibrium was with diffi- lty maintained by loans, an expedient most to be plored, and only justified by the necessities of war, and the maintenance of our existence, but if long continued : might fall into a lamentable state of financial servitude the United States which we could only view with dis- ty. Under the present conditions of exchange, there- e, it would seem that Germany cannot export through :k of resources, the United States through their excess, curious and paradoxical conclusion which might prove some assistance to Great Britain in finding a solution her own troubles. It is therefore of some interest to juire from what directions we may look for a change in : economic position of the United States in relation to : rest of the world and particularly to ourselves. It :ms to me that there three possible events from which a ange might come.

First, a huge loan to Europe might be arranged which uld tend to restore temporarily, at all events, the balance exchange. Such a course presents many objections d possible dangers. It is, however, one which we nnot usefully discuss, as there appears to be no sympathy the suggestion on the other side of the Atlantic.

Secondly, a relative high level of prices in the United ates might increase her imports in relation to her exports an extent sufficient to rectify the exchange. Under rmal conditions this would be an expected and natural nsequence, but there seems to be some ground for the liel that any such result would, in the case of the United ates, be long delayed. The United States possesses ch vast resources within her own borders that she does r need to import any of a wide range of essential com- dities upon which nations generally are dependent. She s plentiful supplies of iron, steel, corn, and meat, and r finished productions cover the widest range of manu- facture. It is true she has to purchase large quantities of tea, coffee, rubber, and certain other important commodities, but her financial position in relation to Europe is very different to what it was prior to the war. At that time she was a debtor nation, and large sums of interest had to be provided in the form of exports. During the war she has liquidated a large proportion of her pre-war indebtedness and has supplemented this by vast loans to Great Britain and other of the Allies.

Instead, therefore, of having to transmit goods in payment of interest, it is probable that the converse is now the case, and it will be necessary for her to increase her imports greatly if only to maintain a trade balance on the basis of the volume of her pre-war exports. For this reason it might be suggested that any serious expansion in her export trade in the near future is most improbable, and the great developments in the United States may not present the serious menace of competition which some of us have been inclined to fear.

(To be continued).

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, February 12, 1920.*

Sir J. J. THOMSON, O.M., President, in the Chair.

THE following papers were read :—

"*Colloidal Electrolytes. Soap Solutions and their Constitution.*" By J. W. McBAIN and C. S. SALMON.

For the first time a comprehensive theory of soap solutions has been set up. This has led to a definition of colloidal electrolytes—a class the members of which will probably prove more numerous than acids and bases put together. They are salts in which one of the ions has been replaced by an ionic micelle.

The ionic micelle in the case of soap exhibits an equivalent conductivity equal to that of potassium ion, and double that of the palmitate ion which it has replaced. Its formula may correspond to $(P')_n \cdot m(H_2O)$, but more probably it is $(NaP)_x(P')_n \cdot (H_2O)_m$, where P' is the anion of the fatty acid in question.

In concentrated solutions soaps exist chiefly in colloidal form, together with sodium or potassium ion, equivalent to the ionic micelle present, whereas in dilute solution both undissociated and dissociated soap are crystalloids of simple molecular weight.

In mixtures of soaps the tendency is to form more micellæ. Addition of electrolytes, however, exert opposing influences, dehydrating and driving back dissociation.

The conception of the ionic micelle serves to explain the behaviour of solutions of dyestuffs, indicators, and proteins.

A modification of the dew-point method is described, which has enabled measurements of osmotic activity and "molecular weight" to be carried out, free from the uncertainties of interpretation of the results obtained for colloids by the osmometer method, and superseding the well known but erroneous data of Krafft.

"*Viscosity of Sulphur.*" By C. C. FARR and D. B. MACLEOD.

The results are discussed of a number of experiments, under a great variety of conditions, on the viscosity of sulphur with temperatures rising and falling between 123° C. and 278° C. The method employed was that of rotating cylinders, usually with a bifilar suspension. A unifilar suspension was, however, employed in the neighbourhood of the point of minimum viscosity. Great care was taken to secure that the sulphur had actually

attained the temperature indicated by the thermometer used. The effects were observed of prolonged heating, also the effects of the absorption of gases, especially $NH_3$ and $SO_2$. The relation of the viscosity to the amount of "insoluble sulphur" present is considered.

"*On Kaufmann's Theory of the Impact of the Pianoforte Hammer.*" By C. V. Raman and B. Banerji.

"*On a Theory of the Second Order Longitudinal Spherical Aberration for a Symmetrical Optical System.*" By Commander T. Y. Baker, R.N., and Prof. L. N. G. Filon, F.R.S.

The authors obtain a formula for the longitudinal spherical aberration in a symmetrical optical system of the type—

$$\Delta x = (At^3 + Et^5)/(1 + Bt^2),$$

where $\Delta x$ is the longitudinal spherical aberration on the axis, $t$ is the slope to the axis of the emergent ray calculated by Gauss' method, and A, B, E are polynomials in the magnification of degrees 4, 3, 6 respectively.

It is shown (i.) that a formula of this kind is, on the average, superior in numerical accuracy to the first two terms of the usual series of aberrations of successive order; (ii.) that it removes a number of difficulties connected with convergency, which occur in the methods at present in use. In particular, developments in powers of trigonometrical functions of the true inclination of the emergent ray are shown to be unsatisfactory.

Certain invariant relations are obtained, connecting A, B, E in general and facilitating their computation.

Formulæ are found enabling the functions A, B, E to be calculated for a combination of lenses when the corresponding functions for the individual lenses are given, and a method indicated whereby the contribution of each lens to the final image defects can be rapidly traced.

"*The Lateral Vibrations of Sharply Pointed Bars.*" By Prof. J. W. Nicholson, F.R.S.

The paper is a sequel to one already published, which arose from a suggestion as to the formation of siliceous deposits on sponge-spicules of a certain type. The present paper deals with an exceptional case, for which the necessary analysis presents unusual features. It is that of a double rod, each half of which is generated by rotation of the parabola $y = Ax^2$ about the axis of $x$. The influence of sharpness on the frequencies and nodal positions of the notes is traced numerically after the general analysis. It is shown that a limiting frequency and nodal position exist, so that the frequency is a lower limit to those producible under any conditions of support. As the rod becomes sharper, all its frequencies tend to this value, while of the nodes, one for each frequency tends to a definite position, and all the others to the extreme ends of the rod. The same conclusions apply to a single rod.

"*A New Method of Spectrophotometry in the Visible and Ultra-violet and the Absorption of Light by Silver Bromide.*" By R. E. Slade and F. C. Toy.

A new method of measuring the absorption of light by a substance has been devised. This method is independent of the relation between density and exposure of the photographic plate.

The following values of the extinction coefficient of silver bromide at various wave-lengths have been determined:—

| λ. | k. |
|---|---|
| 450 μμ | 270 |
| 440 „ | 410 |
| 430 „ | 600 |
| 420 „ | 900 |
| 410 „ | 1380 |
| 400 „ | 2000 |
| 390 „ | 2790 |
| 380 „ | 3800 |
| 370 „ | 5100 |
| 360 „ | 6700 |

This extinction coefficient is defined by the formula—

$$I_2 = I_1 e^{-kd_1},$$

where $I_1$ and $I_2$ are the intensities of the light at poin[ts] centimetres apart in the absorbing medium.

It is estimated that the average error of any of th[e] values is less than 3 per cent.

## NOTICES OF BOOKS.

*Practical Metallurgy.* Second Edition. By Tho[s]. Turner, M.Sc., A.R.S.M., F.I.C. Pp. vii+1[...] London: C. Griffin and Co., Exeter Street, Str[and] W.C. 2. 1919. Price 3s. 6d.

This book was first published in 1908, and has prove[d a] great help to students studying for the degree of B.Sc. [in] metallurgy. It is intended to cover the laboratory w[ork] of the first two years, which also covers the course gi[ven] to dental students, engineers, and others who t[ake] metallurgy as a subsidiary subject.

The author has preserved in the new edition all [the] essential features, but a number of minor revisions h[ave] been made. Additions to the former edition are, directions for the volumetric assay of copper in ores [and] alloys, and the method of ascertaining the porosity [of] firebricks. The table of melting-points has been revis[ed] and a short list of eutectics has been added.

*Oil Analysis.* Ninth Edition. By A. H. Gill, S. Ph.D. Pp. 215. London: J. B. Lippincott Co. 19[...] Price 10s. 6d. net.

The author has divided the book into two parts; the f[irst] part dealing with the physical and chemical tests of c[...] and the second part with the derivation, description, [and] examination of certain oils.

In Part I. the usual tests for oils are enumerated, s[uch] as the specific gravity, flash point, viscosity, &c. W[ith] each test is described alternative methods, and in conn[ec]tion with the chapter on viscosity the author has int[ro]duced into this edition a description of MacMichae[l's] viscosimeter, which works on the torsion principle; it [is] claimed that the accuracy of the instrument is well wit[hin] 0·5 per cent, also it can be applied to colloidal or lum[...] solutions, such as clay, glues, gums, or paints. T[he] last chapter of Part I. is devoted to general consideratio[ns] regarding lubricants and the method to be adopted [in] examining an unknown oil.

In Part II. the technology and the properties of [the] more commonly occurring oils are considered. T[he] following heads will give a good idea of the contents (1) Source and Preparation; (2) Physical Characteristi[cs]; (3) Chemical Composition; (4) Analytical Constan[ts]; (5) Adulteration and their Effects; and (6) Uses.

The book ends with an Appendix which gives, amon[g] many interesting tables, the specifications for oils used [by] the American railroads. The Appendix contains ninete[en] tables, which are all of great value and make the bo[ok] complete.

This is the ninth edition, and this speaks better th[an] words the merit the book has obtained.

The Board of Trade (Licensing Section) announce th[at] Privy Council licences for the export of all coal-tar p[ro]ducts, excluding finished dyestuffs, but including anili[ne] oil and salts, granted prior to January 1, 1920, will [be] revoked as from February 21, 1920; but applications [for] the renewal of any such licences will be considered [if] special cause can be shown.

## NOTES.

ture entitled "Some War-time Efforts in Chemi-try at Gretna," by Mr. J. C. Burnham, C.S.I., o be given before the Fellows of the Chemical n March 4, 1920, has been unavoidably post-'he usual Ordinary Scientific Meeting for the nd discussion of papers will be held on that

Institution.—On Tuesday, March 2, at three 'rof. Arthur Keith begins a course of four lectures yal Institution on "British Ethnology—the In-England," and on Thursday, March 4, Lieut.-delivers the first of two lectures on "The Upper r John Cadman's postponed lectures on (1) Development of the Miner's Safety Lamp," and oleum and the War," will be delivered on Monday nesday, March 8 and 10. The Friday evening on March 5 will be delivered by the Hon. J. W. e on "Military History," and on March 12 by Rouse Ball on "String Figures."

e of Address.—As from Monday, February 23, ss of the Department of Scientific and Industrial will be 16-18, Old Queen Street, Westminster, Telephone: Victoria 7940.

f the aims of the Department of Overseas Trade ng its overseas services into close personal touch siness men, and British firms when sending repre-es abroad are recommended to instruct them to His Majesty's Consular Officers in the countries t and on the Commercial Diplomatic Officer in the of each country, and in the case of the Dominions Majesty's Trade Commissioners. Commenting on ject, His Majesty's Commercial Counsellor in marks "that it would certainly be in the interests ess men generally if they made a habit of calling m and on the Consuls where they are transacting . Experience has proved that while people never appeal to the Consul when in need of assistance equently omit to call and discuss commercial . If a practice of doing so were made, both they ers might derive considerable advantage from busi-ormation and experience.

facility with regard to the opening of credits for payment of goods to be imported into Greece rn afforded by the following Government regula-"Merchants able to produce a certificate from the ial Inspector of their district proving that they have cognised as engaged in business for the period of ars up to date, are no longer called upon to deposit tee in cash. In lieu thereof, the Government the merchant's personal guarantee for 40 per cent value of the credit opened." Commercial circles in have welcomed this innovation, and hope that still facilities will shortly be granted to importers from countries.

Institute of Metals.—The Annual General ig of the Institute of Metals will be held, by kind sion, in the building of the Institution of Mechani ngineers, Storey's Gate, Westminster, S.W. 1, on day and Friday, March 11 and 12, 1920. The ig will commence at 4 p.m. on March 11, and 10.30 n March 12. The following communications are ed to be submitted in the order given:—

h Report of the Corrosion Research Committee, by G. D. Bengough, M.A., D.Sc., Member, R. M. Jones, M.Sc., and Ruth Pirret, B.Sc. (London).
ie Action on Aluminium of Hard Industrial Waters," by Richard Seligman, Ph.Nat.D., Member, and Percy Williams, B.Sc., Member (London).
ie Art of Casting in High Tensile Brass," by J. Neil MacLean (Glasgow).
"The Removal of Internal Stress in 70:30 Brass by Low Temperature Annealing," by H. Moore, O.B.E., B.Sc., F.I.C., and S. Beckinsale, B.Sc., A.I.C. (Woolwich).
"Zinc Alloys with Aluminium and Copper," by W. Rosenhain, B.A., D.Sc., F.R.S., Vice-President, J. L. Haughton, M.Sc., Member, and Kathleen Bingham, B.Sc. Member (Teddington).
"A Model for representing the Constitution of Ternary Alloys," by W. Rosenhain, B.A., D.Sc., F.R.S., Vice-President (Teddington).
"Tin-Phosphorus Alloys," by A. C. Vivian, B.A., A.R.S.M., Member (London).
"Some Notes on the Effect of Hydrogen on Copper," by W. C. Hothersall, M.Sc.Tech., and E. L. Rhead, M.Sc.Tech., Member (Manchester).
"The Effect of Progressive Drawing upon some Physical Properties of Commercially Pure Copper," by W. E. Alkins, M.Sc., Student Member (Manchester).
"The Influence of Cold Rolling on the Physical Properties of Copper," by F. Johnson, M.Sc., Member (Birmingham).
"The Study of Thermal Electro-Motive Force as an aid to the Investigation of the Constitution of Alloy Systems," by J. L. Haughton, M.Sc., Member (Teddington).
"The Polishing and Etching of Zinc for Micro-examination," by H. H. Hayes, Member (Birmingham).
"Idiomorphic Crystals of Electro-deposited Copper," by W. E. Hughes, B.A., Member (London).

## MEETINGS FOR THE WEEK.

*Monday, March 1.*

Royal Society of Arts, 8. (Cantor Lecture). "Recent Research in Cellulose Industry," by C. F. Cross, F.R.S.

Royal Geographical Society, 8.30. "The Opening of New Territories in Papua," by Lieut. E. W. Pearson Chinnery.

*Tuesday, March 2.*

Royal Institution, 3. "British Ethnology—The Invasion of England," by Prof. Arthur Keith.

Royal Society of Arts, 4.30. (Colonial Section). "Trade Routes for the Empire in Africa," by G. F. Scott Elliot.

*Wednesday, March 3.*

Society of Public Analysts, 8. "Detection of Finger-prints on Documents," by C. Ainsworth Mitchell. "Photo-micrography with Simple Apparatus," by C. J. Ward. "Solubilities of Theobromine," by Raymond V. Wadsworth.

Royal Society of Arts, 4.30. "Mongolia from the Commercial Point of View," by W. J. Garnett.

*Thursday, March 4.*

Royal Society, 4.30.

Royal Institution, 3. "The Upper Air," by Lieut.-Col. Ernest Gold.

*Friday, March 5.*

Royal Institution, 9. "Military History," by the Hon. J. W. Fortescue.

*Saturday, March 6.*

Royal Institution, 3. "Positive Rays," by Sir J. J. Thomson.

## NOTES AND QUERIES.

Compressed Hydrogen Sulphide.—I should be glad if any reader could give me information as to the possibility of obtaining cylinders of compressed hydrogen sulphide. I have made enquiries of many dealers, but have not heard of any source of supply.—Charles Forrester, 4, Barclay Terrace, Edinburgh.

# GOUDEKET & CO., Amsterdam, Holland

**PIETER AERTSZSTRAAT, 101/115.** *Telegraphic Address:* "RADIOL," Amsterdam.

*OFFER:*

# Neuburger Chalk, Montan Wax

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*TELEGRAPHIC ENQUIRIES PREFERABLE.*

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Ex-Soldier (20), single, Matriculated, three years' experience in Analysis of Foods, Drugs, Oils Fats, Soaps, Metals, and Coal, desires Position as Assistant Analyst or Works Chemist.—Address, X. S., Chemical News Office, 16, Newcastle Street, Farringdon Street, London E.C. 4.

Ex Sapper, M.M., age 34, married, Grammar and Technical School education, Diplomas 1st class, Certificates in Inorganic Chemistry and Metallurgy, with thirteen years in steel works laboratory, including seven years apprenticeship, desires appointment as Assistant Metallurgical Chemist.—Address, Carter, 137, Bath Row Birmingham.

Young Lady seeks Position in Analytical Laboratory. Good experience.—Address, Y. L., Chemical News Office, 16, Newcastle Street, Farringdon Street, London, E.C. 4.

Wanted, a young Physicist to take charge of Department making Steam and other Pressure Gauges. State salary and experience.—Address, Cliffe, Great Brook Street, Birmingham.

## WANTED TO PURCHASE.

CHEMICAL NEWS, complete set; JOURNAL OF CHEMICAL INDUSTRY, complete set; JOURNAL OF CHEMICAL SOCIETY, years 1870 to 1878 or longer run.—Muller, Bookseller, 26, Hart Street, W.C. 1.

## METROPOLITAN BOROUGH OF STEPNEY.

APPOINTMENT OF ANALYST AND CHEMIST.

The Council of the above-named Borough invite applications for the dual Appointment of ANALYST of Articles of Food and Drugs sold within the Borough, and of CHEMIST to the Council.

The appointment of Analyst will be subject to the approval of the Ministry of Health, and made in pursuance of the provisions of the Sale of Food and Drugs Act, 1875 (as amended by the London Government Act, 1899) and the sale of Food and Drugs Act, 1899.

Applicants must be qualified in accordance with the Regulations of the Ministry of Health and must have had at least three years' practical experience in an Analyst's Laboratory.

A properly equipped Laboratory will be provided by the Council, together with necessary assistance.

The person appointed will be required to enter into an agreement (a copy of which can be inspected at the under-mentioned address) and must undertake not to engage in private practice.

The salary for the dual appointment will be at the rate of £300 per annum, rising by annual increments of £25, to a maximum of 400 per annum, together with bonus at the rate of £50 per annum, according to the scale contained in Award No. 101 of the Conciliation and Arbitration Board.

The appointment will be subject to the provisions of the Stepney Borough Council (Superannuation) Act, 1905, and to the person appointed passing an examination by the Council's medical adviser as to his constitutional fitness for the position.

Applications, stating age last birthday, qualifications, and experience, and accompanied by copies of not more than three testimonials of recent date, must reach the undersigned at this address, in envelopes endorsed "Appointment of Analyst," not later than 12 o'clock noon on Monday, the 8th day of March, 1920.

Canvassing Members or Officers of the Council in any manner whatsoever is prohibited, and will disqualify candidate.

GEO. W. CLARKE, Town Clerk.

Municipal Offices,
15, Great Alie Street, E. 1,
February 17, 1920.

## FOR SALE.

One Second-hand Morgan's TILTING FURNACE, 400 lbs capacity.—Apply, Johnson, Mattbey and Co., Ltd., 78, Hatton Garden, London, E.C

GALL STONES from Cattle for Sale — Write "Gall," care of Street's, 30, Cornhill, London, E C. 3.

G. R.

**MINISTRY OF MUNITIONS.**

BY DIRECTION OF THE DISPOSAL BOARD (MISCELLANEOUS STORES SECTION).

**To CHEMICAL MANUFACTURERS and EXPORTERS**

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STEEL LAP-WELDED CYLINDERS.

With valves and lifting handles, water capacity 62 lbs., weight 7 lbs., length 3 ft. 8 ins., diameter 7⅜ ins. Manufacturers' test pressure 600 lbs. per square inch

Accepted for conveyance of 75 lbs. of Chlorine over British Railways

Also a number of LOW PRESSURE CYLINDERS, suitable for Containers, &c.

And Welded GAS TANKS. Manufacturers' test pressure 400 lbs per square inch. 6 ft. 10 ins. in length by 30 ins. diameter, ⅛ in. plate weight about 11 cwts.

AMMONIA CYLINDERS.

Solid drawn, complete with valves and coir covers. Capacity 14 lbs and 20 lbs. of ammonia. Water capacity 28 and 40 lbs.

Also 20 lb. Ammonia Cylinders without valves, 40 lbs. water capacity and charged 18-lb. cylinders. Manufacturers' test pressure 1500 lbs.

$CO_2$ Cylinders, capacity 28 lbs. $CO_2$, new (unused), each Cylinder tested 3360 lbs. and stamped, with valve caps and coir covers. About 800. By leading British Tube Makers.

Also Foreign $CO_2$ Cylinders.

ACETYLENE CYLINDERS by Thorn and Hoddle, &c., in good condition.

OXYGEN CYLINDERS.

Solid drawn, complete with all fittings and coir covers. Capacity 4 and 60 cubic feet.

HYDROGEN CYLINDERS.

200 lbs. water capacity. 11 ft. 6 in. over by 7½ ins. internal diameter fitted with valves and caps. Manufacturers' test pressure 3600 lbs. per square inch.

LIQUID OXYGEN CONTAINERS.

Spare Chlorine Cylinder Valves and component parts, Coir Covers &c.

Additional Cylinders are shortly expected to be available for disposal.

**NOTE.—For particulars of other Government Property for sale see "SURPLUS," price 3d. at all bookstalls, or by quarterly subscription of 2/- post free, payable in advance to the Director of Publicity, Ministry of Munitions, Whitehall Place, London, S.W. 1.**

AGRICULTURAL COLLEGE
31/3/20

CHEMICAL NEWS

Vol. CXX., No. 3125.

## ENITE—ITS CONCENTRATION AND SEPARATION FROM BARITE.*

BONARDI, Assistant Chemist, U.S. Bureau of Mines.

he past two years a number of articles concerning g and concentration of molybdenum ores have in the technical and mining journals. These, have been confined almost wholly to the descrip- ethods employed in the treatment of molybdenite ire. This has been chiefly due to the fact that : larger deposits of this mineral in the United an of wulfenite ($PbMoO_4$). the other commercial ıum ore. The advent of flotation and its adapt- ı the concentration of molybdenite resulted in the itates producing, during the war and since, more num than any country in the world. Several of concentrating molybdenite ores have been used rying success, depending upon the grade and r of ore treated. The methods which have been ul on molybdenite include rolling and screening s, surface tension and oil flotation processes, and atic methods. Oil flotation has proven so suc- especially on low-grade material, that it is being nost exclusively. As a consequence, it would be say that over 80 per cent of the molybdenum pro- came from molybdenite concentrates obtained by tion, with an average extraction of 70—80 per cent $MoS_2$ with a ratio of concentration of 100 to 1, ng upon the grade of product made. Colorado irst in the United States as a source of molyb- having produced during the year (1918) 665 tons entrates, figured on a basis of 90 per cent molyb- sulphide valued at 1,436,400 dols. ("Fifteenth l Report of the Bureau of Mines, State of lo," 1917—1918, p. 107). This, when compared ie world production of between 250 and 300 tons ir 1915, indicates the importance of Colorado as a of molybdenum from molybdenite ores. The al working deposits in Colorado occur at Climax, t County, and near Empire, Clear Creek County. commercial deposits being worked at the present ccur at Questa, New Mexico; Pitkin, Colorado, ıar Nogales, Arizona. Colorado, Arizona, New ), California, Montana, and Washington constitute ncipal states where either molybdenite or wulfenite, ı, occur. These, as well as the minor deposits of denum ores in the United States, are described by Horton ("Molybdenum, its Ores and their Con- tion," Bulletin 111, Bureau of Mines, 1916).

le has been published concerning wulfenite ores and concentration, and therefore it is desired to emphasise paper the methods employed in the ore dressing of ite ores—especially the separation of this mineral barite gangue. Although there are several molyb- minerals found in this country besides molybdenite ulfenite, these two are the only ores of molybdenum are considered of any commercial importance; there being rare with one exception, molybdite ($_3$.$3MoO_3$.$7\frac{1}{2}H_2O$), which commonly occurs with denite as an alteration product, and the recovery of is difficult by the flotation process.

* ... Franklin Institute, January, 1920.

### Wulfenite.

Horton (*loc. cit.*) describes the mineral as follows:—

"Wulfenite is a molybdate of lead ($PbMoO_4$), and theoretically contains 26·15 per cent of molybdenum and 56·42 per cent lead. It is a heavy brittle sub-transparent to sub-translucent mineral with a resinous or adamantine lustre, and is generally of a wax or orange-yellow colour. It may, however, be siskin and olive-green, yellowish grey, brown greyish white to nearly colourless, or orange to bright red. Its hardness is 2·75 to 3, and its specific gravity is 6·7 to 7. It has a sub-conchoidal fracture and a white streak. In planes parallel with its crystal pyramid faces it has a smooth cleavage, but in other directions the cleavage is less distinct. It crystallises in the tetragonal system with pyramidal hemihedrism. The crystals are commonly square and tabular, and are sometimes extremely thin, with a vicinal pyramid replacing the basal plane. Less frequently the crystals are octahedral or prismatic, the prismatic faces showing the hemihedrism characteristic of the mineral."

### *Qualitative Tests.*

1. One of the best tests is to fuse some of the pulverised ore with sodium or potassium carbonate to which a small amount of potassium or sodium nitrate has been added. The fusion is treated with water, heated, and filtered; the filtrate is acidified with HCl and boiled several minutes to expel all carbon dioxide. Some ammonium or potassium thiocyanate is added, followed by zinc; if molybdenum is present, a bright cherry red colour rapidly develops that will disappear only on prolonged standing in the presence of zinc. If hydrogen peroxide is added to the solution immediately after the cherry-red colour has developed, the colour disappears but returns as soon as the peroxide has been reduced. When only small amounts of molybdenum are present, if the solution is shaken with a small volume of ether after the thiocyanate and zinc have been added, any colour in the liquid will be extracted by the ether and intensified as a golden brown in the ether ring that forms at the top of the liquid on standing. This makes visible a colour that before may have been imperceptible. Should the fusion be imperfect with an extraction of iron in the leach from the fused carbonates, a cherry-red colour will immediately develop on the addition of the potassium or ammonium thiocyanate to the solution. On adding the zinc, however, the colour due to iron disappears, and, unless a large quantity of iron has been brought into solution, this colour will completely disappear prior to the development of any colour due to molybdenum. If the colour reaction of iron and its disappearance on addition of zinc are borne in mind, the above test for molybdenum is excellent (*loc. cit.*, p. 40).

2. With the blowpipe on charcoal, wulfenite decrepitates and fuses, giving a yellow coating of lead oxide on the charcoal, and when heated with soda-ash on charcoal it yields metallic lead; with a salt of phosphorus it gives a yellowish green glass in the oxidising flame, which becomes dark green in the reducing flame; with borax in the oxidising flame it gives a colourless glass which in the reducing flame becomes opaque black, or dirty green.

3. A pinch of powdered molybdenum ore on a porcelain lid, if moistened with a few drops of nitric acid so as to make a paste, and heated nearly to dryness, then followed by 0·5 cc. of concentrated sulphuric acid, will, after being heated to fumes and allowed to stand, produce a blue colour when breathed upon; a drop of alcohol added at this point will hasten this colour reaction. The colour will disappear on heating, but if allowed to stand for some time will reappear on cooling. Water will also destroy the colour.

4. An alkaline solution of a molybdate free from iron, after acidifying with acetic acid, will, on the addition of potassium ferrocyanide or tannic acid, produce a deep red to brown coloration. Pyrogallol under similar conditions will give an orange coloration. None of the tests, how

ever, are as sensitive as the ammonium or potassium thiocyanate test previously given.

*Outline of Methods for Determining Molybdenum and Wulfenite Ores.*

Wulfenite, when powdered sufficiently fine, is completely soluble in a mixture of hydrochloric and sulphuric acids, or nitric and sulphuric when taken to fumes. If desired a mixture of the three acids may be used; only rarely will the residue from such acid treatments contain any undissolved molybdenum. After cooling the hot sulphuric acid water is added, and then, without filtering off the insoluble matter, an excess of ammonium hydroxide. Boil, filter, and wash well with hot water. Redissolve the precipitate in dilute sulphuric acid, and reprecipitate, boil, filter, and wash. The filtrate will be clear and colourless, and the molybdenum will be found in solution as ammonium molybdate. The filtrate is then acidified with HCl, and ammonium acetate added, followed by a few cc. of acetic acid. Lead acetate will precipitate from such solution lead molybdate as a white precipitate. Chromium, vanadium, tungsten, and phosphorus will, however, interfere with this latter precipitation, and if their presence is known they must be removed before the precipitation of molybdenum is made. Phosphorus is usually precipitated along with the iron group; however, to ensure this precipitation it is advisable to add a few cc. of ferric chloride solution before adding the ammonium hydroxide. Chromium and tungsten are rarely found associated with molybdenum ores. Molybdenum is separated from vanadium by passing from $H_2S$ into a slightly acid solution under pressure.

The above acid method of decomposition forms the basis for the successful quantitative determination of molybdenum. At the point where the lead acetate is added to the acetic acid solution, a standard lead acetate solution can be run from a burette until a test drop gives no colour change with a drop of tannic acid indicator solution. This method is the reverse of the ammonium molybdate method for the determination of lead. Better results are obtained, however, if the lead molybdate precipitate is weighed. If desired the molybdenum can be determined, after making the ammoniacal filtrate acid with sulphuric, by passing through a Jones reductor and titrating with a standard permanganate solution. The details for the successful determination of molybdenum in ores as outlined above, and the removal or determination of the interfering elements, have been definitely established and carefully worked out. This will be described in a Bureau of Mines technical paper (Bonardi and Barrett, Tech. Paper 231, Bureau of Mines, "Determination of Molybdenum").

*Source and Importance of Wulfenite.*

Up to 1915, wulfenite ores constituted the principal source of molybdenum in this country. Horton (*loc. cit.*, p. 45) states that:—

"Wulfenite ores from Arizona have supplied the larger part of the molybdenum produced in this country to 1915, and on account of the ease with which they are concentrated they should prove a strong competitor of molybdenite for markets that do not require concentrates with a high molybdenum content."

The deposits in Arizona are largely confined to the four southern counties, Cochise, Pima, Pinal, and Yuma, with a few in Gala, Maricopa, and Yavapai Counties. Besides the deposits occurring in Arizona wulfenite has been reported in several scattered localities throughout the Western States of Nevada, New Mexico, Utah, California, and Montana. The location, geology, extent, and development of all these wulfenite deposits are given by Horton (*loc. cit.*, pp. 44—53). Several of these deposits of wulfenite might be worked at a profit, and would have a better chance to compete with the molybdenite market if ... ding the metallurgical treatment of the concentrates. The writer has suggested in ano[ther] paper—"Notes on the Metallurgy of Wulfenite," publi[shed] in *Chemical and Metallurgical Engineering*, Sept. 1919, xxi., 364—a process for such treatment.

In general, it may be stated that deposits of wulf[enite] are confined almost wholly to veins in which it oc[curs] with other lead minerals, but sometimes occurrin[g in] seams, stringers, and cracks throughout ore bodies are mined for gold and silver.

*Concentration and Associated Minerals.*

The successful concentration of wulfenite present[s] difficulties as the ordinary wet processes of concentr[ation] by jigs, tables, and vanners, such as are used in [con]centrating mills for treating lead, copper, zinc, and [p...] ores, may be applied with success on wulfenite[.] These ores are also amenable to pneumatic separat[ors of] various types, which can be used when it is diffic[ult to] obtain a water supply for the wet processes. Wulf[enite] rarely occurs in finely disseminated form, as is com[mon] with certain tungsten ores. A small amount of cru[shing] will give a free cleavage of the mineral from the assoc[iated] gangue; therefore the conditions for wet concentr[ation] or pneumatic methods, are favourable. In addition[, wul]fenite does not slime to the same extent as some of the common minerals, such as galena and pyrite. The sp[ecific] gravity is high, 6·7 to 7, so that it can readily be sepa[rated] from the accompanying gangue matter, exceptin[g] heavy minerals and barite.

Vanadinite and several of the lead minerals—ceru[ssite,] anglesite, galena, pyromorphite, and mimetite—[which] often occur with wulfenite, are also recovered i[n] wulfenite concentrates, as they have nearly the specific gravity. Usually a concentrate of 15 to 2[0 per] cent $MoO_3$ is the best obtainable when the above [men]tioned minerals occur to any extent in the ore. [Pure] wulfenite contains 39·23 per cent $MoO_3$ and 60·7[7 per] cent PbO. Wulfenite buyers sometimes specify th[at the] concentrate should contain a minimum of 20 pe[r cent] $MoO_3$, or 13·33 per cent Mo. Though the prese[nce of] other lead minerals lowers the grade of concentrat[e, a] metallurgical process recovering the molybdenum i[n a] slag should also recover the lead as bullion, along [with] any accompanying gold or silver. The ores o[f the] Mammoth mine, about 3 miles from Mammoth at S[hultz,] Pinal County, Arizona, were worked originally fo[r the] free gold content alone, which was said to be 6 to [...] per ton. Part of the tailings from these working[s] supplied 750 tons of wulfenite concentrates out of 79[...] of combined wulfenite and molybdenite concentrat[es, which] constituted the total production of this county i[n ...] (J. H. Pratt, "The Steel Hardening Metals," Miner[al Re]sources, U S., for 1903, U S. Geol. Survey, 1904, p[...]).

A flow sheet and description of the wet proce[ss em]ployed in a wulfenite concentrating mill at Mam[moth,] Pinal County, Arizona, which treated the ore fro[m the] Mammoth mine at Shultz, is given by Horton (*lo[c. cit.]*, *Bull.* 111, Bureau of Mines, p. 177; *Min. and Sci.* [*Press*,] 1917, cxiv., No. 8). This mill treated dump tails in [which] the ore had been originally crushed in a stamp m[ill and] passed over amalgamation plates; later the tailin[gs of] this process was cyanided to recover the free gold [after] the first operation. After these two treatment[s were] given the ore, although it was so fine that over 75 p[er cent] passed a 200 mesh, it was treated for wulfenite, [which] amounted to about 1 per cent, or equivalent to ab[out ...] per cent $MoO_3$. It was these tailings that supp[lied in] 1903 750 tons of wulfenite concentrates out of the 79[...] of combined wulfenite and molybdenite concentra[tes pre]viously mentioned. In 1915 it was estimated tha[t the] Mammoth tailings contained 200,000 to 250,000 [tons of] material of 1 to 2 per cent wulfenite. Despite t[he low] grade and the fineness, a recovery of about 70 p[er cent] was made in a concentrate averaging about 23 p[er cent] $MoO_3$ and 61 per cent PbO. This was obtaine[d]

rough 4-mesh, followed by simple classifica-
'hindered settling" classifiers and one settling in series. The spigot product from these was sent to sand tables of the Overstrom, rd, and Wilfley types. It was recommended pany treating this material at that time (June, the extraction of wulfenite could be consider-ed by the treatment of the fines on slime tables nners. The mill has been closed down for since most of the molybdenum during the pplied from the sulphide ore ($MoS_2$). What anges had been made in the flow sheet up to closing down could not be ascertained, as the after closing the mill, had moved out of the

to show the wide range of processes that may fully applied to wulfenite ores in general, con-experiments were carried out at this station by oc. cit., pp. 110–120) which resulted in high . Horton concludes that wulfenite ores in uld be treated efficiently by wet concentration, tely as follows:—
he ore has been crushed in a jaw or gyratory about one-half inch size it should be further rolls to about one-quarter inch, and the product nto three series of sizes. Approximately these ld be as follows:—Through a 4-mesh and on nd through 8-mesh and on 12-mesh; these two e treated on jigs; through 12-mesh and on 20-ough 20-mesh and on 40-mesh, through 40-mesh -mesh, and through 80-mesh and on 120-mesh; sizes to be treated on concentrating tables, and ial through 120-mesh to be treated on slime The jigs should be operated so as to obtain as ncentrates and tailings as possible, and the s, after recrushing (perhaps through 20-mesh), e appropriately sized for reconcentration by the

ove statement indicates the amenability of the type of wulfenite ores to ore dressing methods. states "the costs of concentration wulfenite ores rocesses are, in general, comparable to those of ores of galena, sphalerite, chalcopyrite, &c., by methods."

*Separation of Wulfenite from Barite.*

nite has been found occurring with barite, and it when associated with gangue of such high specific that the problem of separation and satisfactory of the wulfenite becomes difficult, and the adopted for ore dressing should be carefully out. This problem will be taken up in detail in per. Since barite is the highest specific gravity mineral that is found associated with wulfenite it emed advisable to find out whether any special nt would be necessary in its concentration. The m the Mammoth dump, cited above, did not con-y barite, so its separation from wulfenite did not nto consideration. Horton cites no case where gangue was found occurring with wulfenite in preciable quantity.
mple of wulfenite concentrate, whose principal mineral consisted of barite, was kindly furnished Rocky Mountain Station by a copper company ng in Arizona. The company is developing a ite mine containing considerable barite gangue associated with rhyolite, quartz, several lead ls, such as mimetite, pyromorphite, vanadinite, te, and anglesite, and a small amount of copper, ally in the form of chrysocolla. The milled ore d approximately 2 per cent molybdenum; the ore is of a lower grade and must be sorted before g to the mill.
TE.—The separation of vanadinite from wulfenite ... difficult problem; it is the writer's intention to carry on in the future an investigation of this problem).

*Barite "Middling" Material.*

The disposal or treatment of the middling material that was formed at the concentrating mill was held up pending the results of future ore dressing experiments. This middling material contained 52·20 per cent barite ($BaSO_4$) and 5·50 per cent molybdenum in the form of wulfenite. This product represented the barite concentrates or middling material taken from a Wilfley table in treating the original ore. In working on the original ore at the mill it was found that passing material once over a Wilfley table made a fairly clean concentrate and approximately a 60 per cent extraction, if a great amount of this middling material containing the barite was rejected. This result was obtained on treating mined ore that had received no special treatment as to classification except grinding and a simple screening through approximately 10-mesh. Such a feed, when passed over a Frue vanner, gave a 63 per cent extraction and a concentrate ranging from 15 to 17 per cent molybdenum. In this connection it can be stated that the adaptability of vanners to the treatment of wulfenite ores has been only recently noticed to any extent. In treating this particular ore the vanner proved an excellent machine to remove the copper mineral from the wulfenite. Although it was known that wulfenite is somewhat friable it was found that the very fine wulfenite minerals of an unclassified feed would, when submitted to a vanner, readily attach themselves to the moving surface and be retained. This is because the mineral is readily wetted; while the gangue particles, being of lower specific gravity and not so easily wetted, would be carried off by the stream of water, even though the larger in size. After obtaining the richer concentrates from the vanner and the Wilfley table there still remained a middling product composed of grains containing both heavy and light minerals. It is this class of material which will be considered in this paper. It is composed chiefly of barite, quartz, wulfenite, and several of the lead minerals already described. The wulfenite was present in particles ranging in size from minute specks to pieces retained by a 12-mesh screen.

(To be continued)

## OPTICAL GLASS.

### Manufacture and Supply.

At the outbreak of war the position of the country in regard to optical glass, for the construction of the innumerable instruments demanded by the Navy and the Army, could scarcely have been worse. We had been producing about 10 per cent of our normal peace requirements, 60 per cent had come from Germany and the remainder from France. Thus when war began our chief source of supply was immediately closed against us, and the heavy demands which were placed upon French manufacturers by their own Government prevented France from giving us material assistance to fill up the German gap. We were therefore forced to rely upon the extension of our own sources of production for necessary supplies. In 1914 there was only one works in this country manufacturing optical glass; with Government assistance this factory was considerably extended and its equipment improved. A steady and increasing output was obtained, and by concentrating on the absolute minimum number of essential types, the supply, supplemented by imports from France, was sufficient for a while to meet our most pressing needs. In 1916 another factory was built and equipped. It must be appreciated, however, that the difficulties attending the installation of a factory for the manufacture of such a highly specialised product as optical glass are many, and progress at best was but slow. It was not until the following

year that the company was in a position to supply glass in any quantity for its new factory. As the war progressed greater and greater strain was thrown upon our optical glass makers because the French Government were putting heavier demands on their own glass firms, who hitherto had assisted us, and with the entry of America into the war it became necessary for us to provide that country also with glass in considerable quantities. In addition to these calls the need of the expanding Air Force had to be met. The growth of aerial photography had been remarkable, and in order to enable exposures to be made from greater altitudes a new type of lens was required. When it is remembered that these aerial photographic lenses are about 5 inches in diameter and consist of four or sometimes five different glasses, each from one to one and a-half inches in thickness, and that the glass had to pass the most stringent tests, it will be recognised that a still further strain was put upon an already heavily burdened industry. The monthly output was still steadily increasing, fortunately not at the expense of quality, as this also showed a considerable improvement on that of our pre-war supply. It is now satisfactory to record that such considerable progress was made in manufacture that when the Armistice was signed we were producing an amount of optical glass equal to about twice the world's peace consumption. We were turning out over four tons a month. This is no mean achievement when it is compared with the few hundred pounds of glass which represented our monthly pre-war record.

*Quality of the Glass.*

Seeing that the value and importance of optical glass has only recently been brought home to the majority of us by troubles during the war, it may well be asked in what respects our optical glass differs from the ordinary product with which everyone is familiar? If we take the older types of optical glass—those which are known as Ordinary Crown and Dense Flint—they do not differ materially in composition from plate glass and cut table ware. There are certain characteristics, however, which must be present in optical glass, and, to a very great extent, it is the necessity of embodying these features which makes the question of manufacture such a difficult one. Thus, optical glass must be free from air and gas bells, or what is commonly known as "seed"; it must not contain any striæ or veins; it must be free of colour, and have the necessary degree of hardness, indicative of its power to withstand atmospheric deterioration; it must also be transparent and transmit with the minimum loss all the visible rays of the spectrum, and, in particular cases, certain of the invisible rays. In addition to these features, the glass must be as perfect as possible from the point of view of homogeneity, and must be perfectly annealed. Unless the glass be optically homogeneous the production of critical images is impossible, and the visual effects of using imperfect glass may be compared with those observed when looking at an object through the layers of heated air above a sunny beach or over a furnace flue.

*Difficulty in Manufacture.*

Some indication of the complexity and labour involved in production may be given by the fact that some three months are required from the time the ingredients are mixed until the glass in plate form is ready for delivery to the optician. The process of annealing in order to free the optical glass from internal strain, which is effected by first heating and then cooling very slowly, covers ordinarily a period of from a fortnight to three weeks, and in very special cases of "fine annealing" the period may be very much longer. It will, therefore, be seen that not only developm the materials of which the glass is made be very Horton (loc. elected, but also at each stage of manufacture of wulfenite must be exercised in order that none of the better chance to above shall be manifest in the finished ore were knowmaterials, and the pots in which the glass is foundry, must also be very carefully selected otherwise the glass is liable to become coloured with [im]purities which the clay of the pots may contain. M[ore]over, with certain types of glass, there is a consider[able] attack upon the pot, and if this is very pronounced [the] constitution of the glass is materially altered by the [dis]solved constituents of the clay.

*Varieties of Glass.*

It has already been pointed out that during the [early] part of the war, in order to obtain the maximum of out[put], the manufacturers were confined to a limited numbe[r of] types; they were only producing about ten variet[ies]. Through different causes the number of types had to [be] increased, and at the time of the Armistice we were p[ro]ducing about twenty-nine. For commercial purposes [the] number of varieties must be still further increased, and [in] consequence a considerable amount of investigation a[nd] research work must be undertaken. It may perhaps [be] asked why all these varieties are necessary. The expla[na]tion is as follows:—Not only does an optical elem[ent] refract or bend the rays of light which enter and leave [it], but at the same time the light is split up or dispersed i[nto] its component colours. These dispersions are genera[lly] very uneven; that is to say, different parts of the spectr[um] are unequally extended. In order that the optician m[ay] solve the diverse problems presented to him he must h[ave] available a selection of glasses which differ widely in [the] relation of refractive power to dispersion, and also in th[e] proportional dispersion of their power to extend [the] various parts of the spectrum disproportionately. In[ci]dentally, these changes in properties are genera[lly] effected by the incorporation of various metallic oxides [in] the composition of the glass, and it can readily be und[er]stood that the varieties of types are only limited [by] physical conditions. As the result of research and [ex]perience, the glass chemist has been able to establish [a] certain relationship between chemical composition a[nd] optical properties. The production of new types is, the[re]fore, no longer the result of rule of thumb, but is ba[sed] essentially on theoretical considerations.

*The British Industry.*

Before the great advances made in optical glass by G[er]man chemists the British glass industry was strong, b[ut] it was too limited to be able to reach the new Germ[an] competition. Up to about the year 1880 opticians had [to] be content to make use of two varieties of glass, tho[se] which have been previously referred to as Ordinary Crow[n] and Dense Flints, in varying degrees of density. T[he] effect of this limitation was that the necessary correctio[n] could not be applied to counteract the optical defects [or] aberration of a system; in other words, it was not possib[le] to produce with these glasses an image free both from di[s]tortion and colour fringes. Up to this date the Germa[n] opticians had been dependent on imports mainly fro[m] Great Britain for their chief supply of optical glass, an[d] Abbé recognised that no further advance was possible [in] the performance of optical system until new types of gla[ss] were made available. Abbé and Schott therefore unde[r]took a systematic investigation into the possibility [of] manufacturing types which would embody new characte[r]istics, and thanks to liberal subsidies from the Prussia[n] Bureau of Education and the Parliament of the Kingdo[m] of Prussia, they were able to carry on their investigatio[ns] with the result that many new types were evolved, an[d] considerable improvement effected in the quality of th[e] glass produced. The German superiority in the indust[ry] dates from this period, and it was not until necessit[y] imposed by the war forced us to rely upon our own effort[s] that a serious attempt was made again to place th[e] country at least in a position of equality so far as the pro[duction] of this essential material was concerned.

Between 1880 to 1914 Great Britain had dropped a lon[g] way astern in this industry. The only firm making ...

doing so since 1848, and probably continued to do so , tradition; the profits certainly did not come from optical side of their business. It required a national s to demonstrate that the manufacture of optical glass not a lost art in this country. It is generally nitted that so far as pre-war conditions were concerned manufacture of optical glass was not in this country ommercial proposition. The difficulties and uncer-ties of manufacture were very great, so much so that en a successful melt is made not more than 20 per cent the total quantity is available as good glass which can utilised.

*British Quality.*

'hat the manufacture of the highest types of optical ss is possible in this country has been proved by the r; and that its manufacture is essential to the well-ng of the nation is incontestable.

t is probably in connection with the manufacture of ss for photographic lenses that one can best appreciate what extent this country has progressed. The adoption d extension of aerial photography called for the pro-ction of optical glass of the highest type, and as a result very severe tests, both on the ground and under actual nditions of use, it was established that British lenses ide from British glass were superior to those which had en produced anywhere abroad. That this high quality so applies to the lenses may be inferred from the fact at leading British opticians are prepared to admit that nerally the British glass being supplied at the present ne is at least equal to that which they were obtaining om the Continent before the war. Moreover, consider-le quantities of glass of British manufacture are now ing exported both to France and America.

If the optical glass manufacturers will show as much terprise in the next few years as they have shown in the ast five years there is every reason to anticipate that we hall by then have established a leading position in the orld for its manufacture. Optical glass had been placed n the list of essential "key" industries, and the special ssistance thus afforded to manufacturers should encourage hem to make a great effort to maintain and extend the ground which has been won. The increasing demands which would flow from a more prosperous scientific instru-nent industry should ensure the future position of optical glass manufacture.—*Board of Trade Journal.*

THE

# EXTRACTION AND PRODUCTION OF SUGAR FROM DIFFERENT VEGETABLE SOURCES.*

By ARTHUR R. LING.

(Continued from p. 101).

*Extraction of Sugar from Cane.*

THE extraction of sugar from cane is a matter involving very heavy crushing mills, the diffusion process which has been so successful in the case of sugar beet having largely failed when applied to cane. Originally these mills were of a primitive type, driven by horse or other animal power, and this method still obtains in India, which up to quite recently has been the largest sugar-producing country in the world.

The fact, however, that India was the largest sugar-producing country in the world needs some qualification, for the sugar there produced is not of the same type as that to which we are here accustomed. Not only is the crushing done by such primitive means that something like half the percentage of sugar is left in the canes, but the juice when obtained is evaporated in open pans, whereby another considerable portion of the sugar is destroyed. It should be mentioned that the fuel employed for evaporating the juice consists of extracted cane or bagasse as it is called. The native produces what he calls gur or jaggery, a soft sugar containing in addition to cane-sugar a considerable proportion of invert sugar, and in some cases much colouring matter. All this is due to the primitive methods of extraction and manufacture adopted. Besides this, cane grown by the natives is for the most part confined to the temperate districts of Northern India, and is practically a wild species, the canes themselves being about the size of an ordinary pencil, and the sugar-content very low. I may mention that a Government Commission is now enquiring into the whole sugar position in India, with a view of ascertaining whether it is possible to acclimatise varieties of cane giving larger yields of sugar, more especially in tropical India, and in this connection I may mention that much valuable work has been done by Dr. C. A. Barber. The Commission will also deal with the possibility of establishing central factories, whereby white solid sugar can be manufactured, and India converted into an exporting instead of an importing country. Before the war, practically the whole of the jaggery made by the natives was consumed by them, whilst for the need of the white population, some 800,000 tons of sugar, mostly European, was imported.

The modern cane sugar mill is a very heavy piece of plant, consisting of three, four, and in some cases a much larger number of rolls, to actuate which much expenditure of power is required.

The extracted juice is let into a vacuum apparatus, and evaporated until it commences to grain. For a thin solution, such as raw juice, it has been found economical to employ what is called a multiple effect evaporator, that is to say, an apparatus consisting of several members in which the steam escaping from one is made to boil the juice in the next vessel, and so on until the necessary concentration is reached. After the juice has reached the point at which it grains, it is discharged from the last member of the series into a centrifugal machine, where the syrup is removed from it, and the latter is boiled for a second and sometimes a third crop, the residual syrup, which can no longer be made to crystallise, being molasses.

*Extraction of Sugar from Beet.*

In the early days of the manufacture of sugar from beet, the extraction of the juice was accomplished by submitting the rasped roots to hydraulic pressure. At present, however, it is carried out by a process of lixiviation known as diffusion. The roots are first cut into slices and are conveyed by a travelling band to a series of 10—14 cells. Hot water at about 190° F. is then introduced at the bottom of the cell so that it travels up and rises through the mass of slices. The solution thus obtained passes over into the next cell, and so on through the whole series until the slices are extracted.

The next operation is to treat the juice with lime in order to remove certain impurities from it. The lime is then precipitated by passing in a current of carbon dioxide in so-called saturation tanks until its alkalinity is about 0·1 per cent, calculated as calcium oxide. If the saturation is carried further than this then some of the non-sugar substances redissolve. The calcium carbonate and scums are then filtered through a press, after which the filtered juice is submitted to a second treatment with carbon dioxide and sometimes to a third treatment, in this case with sulphur dioxide. The final alkalinity of the juice is then reduced to 0·01 to 0·04 per cent, calculated as calcium oxide. The juice is then let into the multiple effect apparatus and evaporated to the graining or crystallising point. Usually first and second product sugars and molasses are produced. The first products polarise from 95—98 per cent, and the second product from, say, 87—9[illegible] per cent. These limits cannot be strictly fixed. Bee[t] molasses is very constant in composition, consisting o[f] just below 50 per cent of sugar, 10 per cent of ash, th[e] remainder being organic non-sugar matters. By suitabl[e]

* [illegible] Arts of Dummer. February, 1920.

washing the first products in a centrifugal machine, beet crystals polarising over 99·8 per cent can be obtained.

Sugar cane and sugar beet are thus the two chief sources of sugar in the world's supply. There are, however, certain species of palm from which sugar is extracted. In India some of these palms yield as much as 3 tons of jaggery sugar to the acre. Palm sugar is, however, never likely to develop beyond the limits at which it stands at the present time, for it must not be forgotten that it requires twenty years before a palm tree attains maturity. A certain amount of sugar is obtained in America from maple, but on account of its cost this is to be regarded as a sweetmeat rather than as an ordinary article of consumption.

The phase of the sugar question of the greatest importance to us in the British Empire is whether we can by any means render ourselves self-supporting. I am Chairman of a Committee formed by the Society of Chemical Industry known as the Empire Sugar Supply (Technical) Committee, and that Committee has drawn up a report indicating the position of the whole situation. In the first place, we have discussed the possibilities of establishing a beet sugar industry in this country. The experiments of Dr. G. Schack-Sommer, from 1889—1895, were the first to prove that sugar beet equal in sugar content and purity to the best obtained at that time on the Continent could be grown in the United Kingdom. Further, from several hundreds of analyses I have made during the last ten years of beets grown in different parts of the United Kingdom, I have come to the conclusion that sugar beets can be grown in this country having a sugar-content and purity as high as those produced on the Continent. The industry, however, requires an enormous amount of agricultural attention, and necessitates much agricultural labour. Deep ploughing is necessary, in order that the crowns of the roots may not protrude above the surface of the soil, and continual earthing up is necessary for the same reason. Sugar beet is a selected variety of the mangold wurzel, but the two are grown for entirely different objects—the sugar beet for sugar production, and the mangold wurzel as a more or less complete cattle food. Farmers have often stated that they can obtain as much as 40 tons to the acre of mangold wurzels, whereas they can only get something like 12—15 tons of sugar beet. Mangold wurzels are grown in such a way that they contain something like 3—5 per cent of sugar, whilst the purity of the juice, that is to say to percentage of sugar, in the total soluble matter is something like 55—60 per cent. In view of the purpose for which it is grown, the mangold wurzel does not need so much attention as the sugar beet in its cultivation. The final roots contain a much larger quantity of substances other than sugar, which they derive from the soil. The roots are allowed to protrude above the surface of the soil, and usually this causes the crowns to become green. It is quite otherwise with the sugar beet, in which the object is to increase the amount of sugar produced to its maximum, and to keep other substances down to a minimum. It is not possible for me to traverse the whole of the pros and cons of this question on the present occasion. Much as I should like to see a beet sugar industry established in this country, I quite endorse the views of Mr. J. W. Macdonald that the establishment of such an industry would make another heavy call upon our coal, of which, as you are aware, there is such a need of conserving. It is only right to add, however, that the cultivation of sugar beet as a rotation crop does improve the soil for cereals and other crops, mainly on account of the deep tilth which it necessitates. On the other hand, there are so many parts of the British Empire, India, West Africa, the West Indies, and numerous other totally undeveloped colonies, where cane could be cultivated and a sugar industry established. In the case of cane, as I have already stated, not only is the yield per acre of sugar twice or even more than that which is obtained from beet, but it affords its own fuel. When we look at our vast Empire and the possibilities it has of growing cane, we should, I think, make every endea to increase the production of sugar from that so within our Empire rather than purchase as we did be the war in this country, over 80 per cent of the t sugar we consumed from Germany and other Contine countries.

So far as the brewing industry is concerned we hav remember that beet sugar is of very little significa Raw beet sugar cannot be used as it is well known to duce troubles, and refined beet sugar is not suit because it does not communicate to the beers that lusc flavour which is obtained from raw cane. Conseque the brewer's interest in the sugar question becc essentially one of increasing the production of cane ra than of beet. I should like to point out in connec with the use of sugar in brewing that raw cane sugars very liable to be contaminated with bacteria. H when they are employed in the brewery the greatest should be taken that their solutions are sterilised by pr boiling. Possibly in time this may be overcome, sinc some of the sugar plantations where scientific method extraction have been introduced the liming of the juic carried out, so that in these cases there is less chanc bacterial contamination of the raw sugar, in additio which a cleaner product is obtained. As things stan the present time, there can be no doubt that the us refined sugars such as the majority of brewers emplo perfectly justified.

I should like, in conclusion, to express my thanks to A. G Eastick for the loan of lantern slides from his complete collection.

### Discussion at London Section.

The President (Mr. S. O. Nevile) said that he thot every practical brewer was primarily interested in sugar he obtained in the mash tub. On the other ha nearly all of them relied to a considerable extent on adjunct cane-sugar; and consequently Mr. Ling's pa dealing with that particular part of the subject wa great interest. They had with them that evening William Martineau, who he thought was the originato at any rate a moving spirit, in an association called British Empire Sugar Research Association. He felt that they would be interested indeed if Mr. Martin would tell them something of what that research asso tion proposed to do. He would like to ask if that b were associated with the committee in which Mr. I had said he was interested. That research associa might have some bearing on their own research schem the Institute of Brewing; sugar being so importa matter it might well prove that to some extent they m work together, perhaps not so much in encouraging production of sugar, but possibly in the development improvement of the methods by which it was prep for brewing.

Mr. William Martineau said that he was very gla the opportunity of saying a word about sugar resea because he hoped brewers, as large users of sugar, w interested in the matter and would eventually bec still more interested. Referring to Mr. Ling's Comm of the Society of Chemical Industry, as that commi and the sugar research committee were both doing w of the same kind, with the same object, it had b decided that these two committees should link up toget rather than over-lap in their work. He agreed with Ling that the British Empire should aim at being s supporting in sugar; he hoped that we should never ag see German beet sugar in this country. With this ob in view, some three years ago, a meeting was ca together of leading people representing various branc of the Sugar Industry all over the Empire. That c mittee finally became a very important organisat known as the British Empire Producers' Organisat The sugar section of that organisation worked very h

re could produce all the sugar required for the ire, if the Government would only give them a little to start with. In other words, they were out for ial preference. As is known, colonial preference has been granted, which should be a great help to ane-sugar growing colonies, and with this assistance, ne planters set to work in the right way, there was no t England would be quite well able to do without nan sugar in the future. The Germans had made a t success of beet sugar, because they had gone in for arch; it was therefore important that cane-sugar prong parts of the Empire should take up research, and their machinery, methods, and processes right up to . With the object of starting a comprehensive scheme igar research, rather more than twelve months ago, a isional committee was formed, representing not only ters, but every branch of the sugar industry within Empire, and with the support of the Government Dement of Industrial and Scientific Research, the British pire Sugar Research Association came into being, and registered at the end of July of this year. This ociation was now governed by a council representing ar planters, sugar refiners, and sugar users of every l, including brewers, the Brewers' Society being repreed on the Council by Mr. F. P. Whitbread and Mr. ham Aldous. The aim of the Association was to blish, in co-operation with the Government Departit, an Empire scheme for the scientific investigation of problems arising in the sugar industry, and to enrage and improve the technical education of persons o were, or might be, engaged in the industry. By so ng it was hoped vastly to increase the production of e-sugar within the Empire, which would be to the great antage of all industries which used sugar as a raw terial. He hoped that the brewing industry would our this scheme with their practical support. A spectus had been sent out to every brewing firm in the ntry, and he hoped head brewers and chemists would dy that prospectus, and not only become members themres, but advise their firms to support the scheme in as istantial a manner as possible.

Captain H. L. HIND said that he had always been very ch interested in the Beet Sugar Industry; and wished know how it was proposed to overcome the difficulties transport in England where the railways were already rburdened. He had seen the supplies of the Army in ance held up or delayed when the beet campaign rted in the autumn. Trucks could not be obtained as ey were wanted for the beet. How was that going to got over in England? He thought it would prove to one of the greatest obstacles to the setting up of the lustry, as there were so many trucks wanted in such a ort time just when the harvest came. Mr. Ling had own on the screen Char filters. He had had the opporiity of seeing a few sugar factories, but they were not ing Char filters, and he was told that the latter were ite antiquated.

Dr. G. SCHACK SOMMER said that he was very much in vour of the introduction of sugar beet into this country. though he believed the cost of making cane sugar was uch lower than that of making beet sugar, due to the ct, to which Mr. Ling drew attention, that the cane gasse supplied the fuel for manufacturing the cane gar, whereas beet sugar manufacturers had to rely on al or other bought fuel, the advantages of introducing etroot sugar into this country would be appreciated by rmers, because, as the sugar beet required intensive ltivation, they would increase their crops to such an tent that the land which they planted with beet would t be missed. Continental experience had demonstrated nclusively that beetroot sugar was not an exhaustive op; on the contrary, it increased the fertility of the soil a proper rotation of crops was observed. Wherever gar beet was introduced crops of wheat and other corn ops were so much increased that the beet was simply an

Further, the beetroot gave employment to men in the country at a time of the year when there was no work for them to do, so that they could keep very much larger armies of working men in the country than now, because usually they had no work for them in the winter. Again, when the sugar had been extracted from the beet, there was pulp left which would feed the cows or any other animals. In that way many more cattle could be kept on the same farm than could be done without the sugar beet crop. He thought that those things went a long way in favour of recommending the introduction of the sugar beet industry.

The CHAIRMAN said that he felt they were all very much indebted to Mr. Ling for his paper. He thought that they were up against the farmer in this country who was against growing beet. In his part of the country they had had some experience. The farmer could not understand why, when he sent a truck of beet to the factory, if he sent 10 tons to the railway station he was only allowed, say, 8 tons pure beet. That had been the cause of all the trouble in growing beet. The farmer would not take the factory figures. As they knew, when the beet came into the factory they took about two skipfulls out of each truck, which went into the laboratory, was washed, and the dirt taken away. From that amount of dirt in the two skips the amount of dirt in the trucks was calculated. The farmer would not take that for granted, but wanted to see the condition himself. Another great trouble was the question of labour. There was a lot of imported labour in Norfolk from Holland, Germany, and Austria; and he believed that imported labour put up the backs of the farmers and the local labour. The local labour would not take their instructions from these Continental men. He thought, unless they educated the farmer and the labourer, beet sugar would not be much good in this country. Those who had been in Germany and had seen the beet seed storehouses, knew the enormous care that was taken to select the seeds. If they could do all those things with beet sugar why could not the Empire produce more cane sugar? He believed 99 per cent of the machinery used in the cane factories abroad came from Scotland. He could not understand why that was so, and at the same time they were producing less cane sugar in the Empire. He had used English beet sugar in mineral waters. Whether it was properly refined or not he did not know, but he had found it gave a sort of ropiness.

Mr. LING (in reply) said that he had not gone into detail. He was afraid he had misled many of them by showing the charcoal cistern and not properly explaining in what connection he showed it. On the Continent, for some years past the first runnings sugar were the ordinary white beet crystals, which were only of a slight brownish colour and polarised at 99·5 per cent with 0·1 per cent of ash or less, and no char whatever was used in their production. The *masecuite* was simply washed in the centrifugal. He quite agreed with Dr. Schack Sommer that if the beet sugar industry were introduced into this country it would be of very great help to agriculture; but at the same time they had great difficulty to persuade the farmer of those things. First of all the farmer told them that he could get 40 tons of mangolds per acre, whereas he only got some 15 tons or less of beet. He also did not take kindly to the exhausted slices. If the industry were worked on a co-operative system as they did on the Continent, giving the farmer an interest in the sugar factory, and the sugar manufacturer an interest in the farm, he had no doubt they would be able to get together some sort of beet sugar industry in this country. With regard to transport he agreed with Captain Hind that that was a difficulty; but he looked forward to the industry being established in such localities as commanded transport by canal. He thought they had a sufficiency of canals; but he did not believe that the sugar industry would ever assume very large proportions in this country. But if beet could be grown and factories established with command of canals, and the beet distributed by water to different centres, he thought they

would get over the difficulty of transport to a great extent. Dealing with what the Chairman had said as to ropiness, the sugar which was turned out in cane sugar factories was raw sugar, often contaminated with organisms which refining removed, and therefore there was always the danger of ropiness. The ropy organism of sugar, *leuconostoc mesenteroides*, was far more prevalent in beet sugar than in cane sugar. When he had been analysing beetroots he had always found if he took a little earth away from the root and put it into beet juice which was sterilised, he could get a fair growth of *leuconostoc mesenteroides* by the next morning. Beet juice seemed to be a particularly suitable medium for its cultivation, much more so than cane juice.

A vote of thanks to the Author was passed unanimously.

(To be continued).

## NATIONAL CONFERENCE OF MANUFACTURERS AND PRODUCERS.

(Concluded from p. 105).

The only other event which seems left is that exchange may be restored by flow of capital from the United States through natural channels. At the present time it would appear that the results of her prosperity are in a great measure being absorbed in increased developments of her home resources and upon home productions, as indicated by the high rate of interest which new capital can still command in that country. The time, no doubt, will ultimately come when the demand for capital for fresh developments in the United States is satisfied. The rate of interest would fall in consequence, and through the ordinary channels capital would then be capable of employment more profitably in other parts of the world, whereupon a steady flow of capital from the United States would take place, similar to the steady flow of capital from this country to which we ourselves were accustomed for so many years before the war, and owing to the same economic causes. This prospect is perhaps not altogether pleasing, but so far as the capital is devoted to the undeveloped portions of the world, we also should derive benefits by an increase in our opportunities for profitable trade, just as in the past the United States and Germany reaped no small measure of advantage from similar pre-war developments by ourselves.

If we turn our thoughts to the economic position of our own country, we find at present some of the evils which exist in Germany, but fortunately to a much less marked degree. We can congratulate ourselves that we have borne the shock of war so well. Many problems, both difficult and delicate, still await solution, but we, at all events, can rest satisfied that in the case of our own country those problems are not insoluble, and that with good will and with a spirit of co-operation and understanding among all sections of our people, solutions will be found.

In Great Britain we also have been suffering from the evil of consuming more than we produce. The economic action of a nation is the resultant of the action of the individual members of that nation's community, and under ordinary circumstances, seeing that individuals as a rule live within their means, individuals in the aggregate, that is in the community, automatically consume not more than they produce. Where, however, the Government is borrowing large sums of money—our Government is borrowing at the present time about a million and a half a day—the nation may be unwittingly consuming that amount in excess of its production, and this as Mr. McKenna clearly pointed out is particularly the case where the borrowing takes the form of loans from the Bank of England. In our case we may be proud to feel that we can stand the strain, but the immediate and inflation of prices and the general cost of living; inflation which could only be checked by trade depres and discouragement to expenditure. Fortunately, unfortunately, the reverse is the case. The wo demand far exceeds the supply, and no element is pre to resist the constant tendency of prices to soar upw

There are two directions in which something effec could be done to remedy the economic difficulties which we as a nation are suffering. The first, in judgment, is of prime importance. We must see that we no longer consume more than we produce, and essential step is that Government borrowings must ce It appears to me that it is almost useless seeking o remedies until this great one is applied. It has be matter of great disappointment to many of us that t has been so much delay in bringing the national inc and expenditure into equilibrium. Ill informed critic of the Government is stupid, and I think here ou place. It is not possible for us to say with any fidence aye or no whether the Government have d everything that would have been possible to accomp this end. In any case, however, it is no use crying spilt milk, or criticising the administration for past fa Our duty to-day should rather be to emphasise importance of economy, which doubtless the Governm like many others, finds far from easy to practise in atmosphere which, we must reluctantly admit, is one extravagance. The evil, however, does not strictly in individual extravagance. The evil, as I have poi out, lies in our national failure to balance our expendi with our income, and it is upon this point whic suggest special emphasis should be laid.

The second remedy is an increase in production. unnecessary for me to emphasise this point, or reite the statement now almost threadbare, that as a natio must increase our productions if high wages are to assured and the enjoyment of those increased ameniti existence by our people which we all earnestly de I fear, however, prices are likely to rise what we may do.

It is manifest that while a cessation of Govern borrowing will remove a disease, a continued exces demand over supply must in itself result in advan prices, even if for reasons themselves economic healthy. Manufacturers, however, can hardly fail to alarmed at the prospect always at the back of their m that one day a reaction must come, and that the hi the pinnacle the more disastrous the fall. At the s time, we can derive some consolation from the reflec that high prices are generally accompanied by prospe

It is perhaps unnecessary for me to urge upon the ma facturers the importance of increasing reserves out profits, both to supply the greatly increased floating ca required by to-day's high prices, but still more to pro against the day of depression which experience teache is almost inevitable.

Great and abounding prosperity will in itself do m to ease our national war burdens, while any set-bac the nation's commercial prosperity might result in ser unemployment. We are all most anxious to improve conditions under which the workers of this country Much has already been accomplished in the directio shorter hours and more favourable conditions, and m is hoped from social legislation which we are promi particularly in the direction of better housing for people. A set-back to commercial prosperity wo therefore, be particularly unfortunate at the present t The duty of our manufacturers and producers w appear to be clear up to a point. We must seek to d utmost in our power to assist in an increased produc and while we must not grudge the return of German a producer for the world, for the reasons I gave discussing the German situation, we must see to it the British manufacturers assure for themselves the la possible share in the supply of the world's requireme

ices, they must seek as far as possible by co-operative fort to restrain them.

Sometimes attacks have been levied against combina- ons and associations under the impression that their ndency is in the direction of inflating prices. I am tisfied that this is a mistake. At a time like the esent, the influence of popular opinion is very great, nd where large combinations or associations are ttling price policy, popular opinion cannot be absent om their minds. Where, however, no price organisa- on exists, and each manufacturer in an industry pur- ies an independent policy, there is no such restraining fect, each manufacturer in his mind putting the blame n his competitors, whose example he is constrained to llow if he is not to be drowned with business.

Reviewing the economic positions of the Continent, f the United States, and Great Britain, there is much ound for anxiety, but at the same time there is no ood ground for dismay. Our most serious difficulty is e high cost of food and other essential commodities hich we can only obtain from the United States.

If I am right in my view that it may be a long time efore the imports into the United States can re-es- ablish the exchange, it would seem a matter of im- ortance that our purchases from that country should, s far as possible, be confined to essentials, as the osition must be aggravated by every purchase of non- ssentials that we make. I know the prejudice which s widely exists against any interference with imports into his country, but in view of the importance of obtaining ur foodstuffs, cotton, spelter, and other essential raw aterials which we purchase from the United States as heaply as possible, I believe it would be wise, temporarily t all events, to restrict the importation from the United tates of everything in the nature of luxuries or non- ssentials. Artificial interference with the economic osition is generally objectionable, and generally brings etribution in its train. It is not, however, easy to see hat a policy of restricting certain imports could have any bjectionable consequences of a serious moment, while it ould be altered when warranted by a change in the osition.

The high cost of living in this country is a matter for rious concern, and unqestionably should be controlled y any method which is not economically unsound. Many peakers and writers have dwelt upon the importance of icreased production as the solution for our difficulties, and is necessary for me to emphasise such an obvious truth, ut while, as I have said, we have great opportunities for icreased production, the essential point is the ultimate elation between production and consumption. It is itally important, therefore, that those engaged in pro- uction should produce as much per capita as possible, and hat the nation as a whole should curtail unnecessary con- umption. We producers have considerations of self- nterest to urge us to use every endeavour to increase pro- uction, and exhortations to that end are as needless as hey would be impertinent.

On the other hand, it is not proper for us manufacturers o lecture the rest of the population on their duty. With reat commercial prosperity, and ample employment, here is a tendency for the workers to look not only for igh wages but more leisure. We can hardly blame them. n times of great prosperity those who receive financial enefit in the form of profits are inclined to spend more pon pleasure and enjoyment, and again we cannot blame hem.

To preach to the workers greater effort and to the onsumers greater economy is, I fear, to preach in vain. t all events let us leave that to others; but for ourselves member that in the national interest it is our duty to in- rease production to the utmost in our power, and also in he national interest to develop exports, particularly of ommodities which are not essential for home production n other branches of industry.

High cost of living, on the one hand, and large profits and the obvious enjoyment of wealth on the part of certain members of the community on the other, inevitably give rise to social discontent and criticism of the individualistic and capitalistic system. Demands are made for a fairer distribution of wealth, confiscation of capital, and the nationalisation or control of all branches of production by the State.

Most of us would agree that there are social conditions prevailing in this world which are not completely satisfac- tory, *but we are confident that any artificial interference* with the freedom of individual enterprise would do more harm than good. It is our experience that the driving incentive of self-interest is the most effective method that has yet been discovered for ensuring the development o enterprise and the general well-being of the nation as a whole. At the same time criticisms which are directed against existing conditions must be met, either by con- vincing argument or by practical action. I hope the con- vincing argument will be forthcoming as the result of the present Congress, when many of these subjects will arise for debate. With regard to practical action, much has already been attempted, but much doubtless remains to be done. The great proportion of social grievances which still exist are grievances which require a political remedy, and *their consideration and treatment must, in* consequence, rest with the Houses of Parliament. Em- ployers in these matters can do nothing more than offer to the Government their encouragement and assistance.

*The greatest practical opportunity open to employers is* possibly to be found in their relations with their work- people. It is hoped that through the wide creation of Whitley Committees and Works Councils there will gradually grow a better general understanding of econo- mic questions, economic difficulties, and trade require- ments, and a better appreciation of the essential char- acter of partnership which must exist between all parties to productive activity. From the national point of view it is hoped that something appreciable has al- ready been accomplished by the National Alliance of Employers and Employed. Industrial peace with sym- pathetic understanding should be our aim.

We must remember, however, that the real cause of social grievances can only be removed by an improve- *ment in the standard of living, and that this cannot be* achieved without more work and greater efficiency on the part of all concerned. If this is attained, we have nothing to fear, and Great Britain, a united nation, can face the trials and difficulties which lie in her path with confidence and with hope.

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## RELATIVE COSTS OF COAL AND FUEL OIL.*

### AMERICAN EXPERIMENTS.

THE growth of the movement in favour of the substitution of oil for coal as fuel, especially in shipping circles, lends considerable interest to articles published in recent issues of well-known American journals on the question, and the various views expressed are therefore summarised below.

When it comes to a comparison of costs between oil and *coal it depends, of course, upon the price of* each and the efficiency coefficients of the two fuels.

*Results of Experiments.*

Comparative tests of oil and coal fuel on the same type of boiler, which have been carried out in America, the boiler efficiency obtained with coal ranged from 71·5 to 74·6 *per cent, which is probably somewhat higher than* would be obtained in commercial practice where a 60 to 65 per cent net efficiency is considered good. The average duration of the test was ten and a-half hours and the mean steam pressure gauge 161·4. In the case of oil

* From H M. Commercial Secretary, Washington.

the efficiency figures ranged *from 69·6 to 83·29 per cent,* with an average for six tests of 78 per cent, the trials averaging eight hours in duration with a mean boiler pressure of 176 lb. per square inch. Here again the figures were somewhat higher than would be obtained in commercial practice.

*Comparative Costs.*

The average evaporation in the boiler was considerably over 8 lb. of water per lb. of coal as against 15 lb. of water per lb. of oil. With 42 gallons of oil to the barrel of 325 lb. this means that 1 metric ton of coal is equivalent to about 3·2 barrels of oil, which, with oil at 5 cents per gallon, would be equal to coal at 3·2 by 42 by 0·05 equals 6.72 dollars per ton.

Some years ago a change from coal to oil was made at the South Chicago Steel Works, from which some interesting comparisons were obtained, *based on actual* operating conditions. In this case fourteen horizontal return tubular boilers required 25 men to operate them with coal. With oil 6 men operated the boilers, thus saving the wages of 19 men. For one week's work 2731 barrels of oil were used, as against 848 tons of coal for the same work, showing 3 22 barrels of oil equal to 1 ton of coal. With oil at 60 cents a barrel and coal at 2.15 dollars per ton (prices prevailing at that time) there was a saving of 10 2 per cent in favour of oil.

*Continued Use of Coal Justified.*

Since then oil in the same locality has risen in price to 1.68 dollars per barrel—280 per cent—while coal has increased to 3 60 dollars, or 67 per cent. On the basis of present prices, 2731 barrels of oil would coast 4588.08 *dollars, while coal for the same service would cost* 3052 80 dollars, showing a difference of over 1000 dollars a week in favour of coal, even after deducting saving in labour at 4 dollars per day per man, which is 100 per cent increase over the wages figured at the time the tests were run.

Even at present prices the use of coal is justified in the majority of cases, with the existing ratio of oil at, say, 5 cents per gallon, as compared with coal at 6 dollars per ton.

*Oil Fuel for Special Purposes.*

The legitimate field for oil is in special applications. Thus it is used in the navy on account of the longer radius of action which it gives. In the same way it is used for special furnace work and metallurgical purposes, for tractors, &c. Each case must be studied with respect to its local peculiarities.

If, in a steam plant, the conditions are such that coal is burned at low efficiency, due to poor drafts or low head-room or improper furnace arrangements, or if the delivery of coal is very expensive, due to inaccessible locality, then the use of oil may be indicated.

If, *on the other hand,* a steam power plant is using coal at high efficiency under good furnace conditions, with proper head-room and draft, with carload delivery and favourable conditions as to ash handling, &c , then coal will show the cheapest cost at present prices.

*Relative Heat Values.*

It is also interesting to compare the relative heat value of oil with coal when oil sells for 6 cents per gallon, a very conservative price. In order to change the price of oil at 6 cents per gallon to the cost of a ton of oil, the following formula is used :—

$$\frac{2000 \text{ (lb. per ton)}}{7\cdot5 \text{ (wt. in lb. per ton)}} = 266\ 6 \text{ gals. per ton.}$$

$$\frac{266\ 6 \times 6 \text{ c. per gal.}}{100} = 15\cdot99 \text{ dols. per ton of oil.}$$

With oil giving 19,000 (a very liberal figure) B.T.U. per lb., the following net B.T.U. for 1 cent would be

$$\frac{19{,}000 \text{ B.T.U.} \times 2000 \text{ (lb. in ton)}}{15.99 \text{ (dols. cost of 1 ton of oil)} \times 100 \text{ (cents to dol.)}} = 23{,}765 \text{ net B.T.U for 1}$$

The net B.T.U. for 1 cent of 23,765 is then a basic figure use in comparing oil with coal upon a price-per-ton bas The following formula shows the method of figuring a arriving at results :—

$$\frac{\text{B.T.U. as received in cost} \times 2000 \text{ (lb. in ton)}}{23{,}675} = \text{the pri}$$

that coal could be sold for at the plant when oil sells f 6 cents per gallon.

The real cost in a boiler plant is the cost of evaporati 1000 lb. of water from and at 212° F. whether coal or is used. So far as Chicago prices were concerned duri *the past year, coal could be sold for two or three tim* the prices actually realised before the cost of oil would *equalled.*

It must be borne in mind that the comparisons ma were upon heat content only, and did not take into co sideration plant performance. A fair average efficien for a plant burning coal is, no doubt, about 63 per cer for oil 78 to 80 per cent when it is very carefully operate —*Board of Trade Journal.*

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, February 19, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read :—

"*Studies of Photosynthesis in Fresh-water Algæ.*— The Fixation of both Carbon and Nitrogen from t Atmosphere to form Organic Tissue by the Green Pla Cell. 2. Nutrition and Growth produced by High Gaseo Dilutions of Simple Organic Compounds, such as For *aldehyde and Methylic Alcohol.* 3. *Nutrition and Grow* by means of High Dilutions of Carbon Dioxide and Oxid of Nitrogen without Access to Atmosphere." By Be jamin Moore, F.R.S., and T. A. Webster.

The primeval living organism, like the inorganic c loidal systems which were its precursors, must ha possessed the power of fixing carbon and nitrogen, a building these up into reduced organic compounds wi uptake of energy. The source of the energy was sunlig

This power is still possessed by the lowliest type synthesising cell existing, namely, the unicellular alga.

A synthesising cell must have existed prior to bacte and other fungi, since these can exist only upon orga matter, and the primeval world before the advent of l could contain no organic matter.

Their specific reactions show that even the ult microscopic filter-passing organisms are highly organis products on the path from the inorganic towards life, a it hence follows that there is a long intermediate rang evolution. The first synthesising system acting up light was hence probably an inorganic colloidal system solution, capable of adsorbing the simple organic s stances which it synthesised. It is hence futile to sear for the origin of life at the level of bacteria and torulæ.

As complexity increased with progressive evoluti more and more rapid transformers for the capture of t energy of sunlight came into existence. Such transform are found in the green cell for fixation of both carbon a nitrogen. The earlier transformers in the organic collo systems can only utilise light of short wave-lengths; later transformers in the living cells are adapted to util

s are lethal, are cut off by their colour-screens of ophyll, &c.

"The Properties of Colloidal Systems. IV. Reversible tion in Living Protoplasm." By W. M. BAYLISS, S.

ith intense dark-ground illumination it is possible to that the apparently clear pseudopodia of *Amœba* are with numerous very minute particles in Brownian ement, thus affording further evidence of the liquid osol nature of simple protoplasm.

y electrical stimulation, this sol can be reversibly ged into the gel state, evidenced by the sudden cessa of the Brownian movement.

"The Development of the Auditory Apparatus in *Sphenodon punctatus*." By F. J. WYETH.

his memoir contains a detailed and fully illustrated unt of the development of the auditory apparatus and ciated structures in the New Zealand Tuatara. As important type is on the verge of extinction it was ight desirable to treat the subject fully, although as it be expected, the developmental history agrees ely with that found in other reptiles. The work was ied out chiefly by means of wax plate reconstruction lels.

he third and fourth visceral clefts are closed by a backdly growing operculum, but separate dorsal and tral openings of the clefts were not observed. The tence of two pairs of head cavities was confirmed—e of each pair communicating with each other by sverse canals. The vascular system was found to bit a number of primitive features.

he region investigated includes cranial nerves vi+xii., devel pment of which was worked out in detail. The eral development of the internal ear and auditory nerve oroughly normal. The development of the *cristæ* and *ulæ acusticæ* from the primitive neuroepithelium is n in detail. A well-marked *macula neglecta* is nd.

s regards the much-debated question of the origin of columellar apparatus, evidence is brought forward in port of the contention that this is essentially a derivaof the hyoid arch, and it is maintained that the itory capsule contributes at most a portion of the footte of the stapes.

he development of the tympanic cavity, functional panic membrane, extra-columellar sinew, and chorda pani is described. The distal portion of the anterior panic diverticulum undergoes isolation and finally appears.

## INSTITUTE OF CHEMISTRY.

the Forty-second Annual General Meeting of the Inute of Chemistry, held at 30, Russell Square, Sir BERT ROBERTSON, Vice President, occupied the Chair the place of Sir Herbert Jackson, the President, who s absent through illness.

in moving the adoption of the Report of Council, Sir bert read the President's Address, in which reference s made to the position of professional men under preling economic conditions. Notwithstanding the limited mber of appointments carrying reasonably high salaries d the difficulty of rising above the standard of diocrity, most of the professions were attracting such a gh proportion of the educated youth of the country that y were likely to be overcrowded. On the other hand, Government and the industries of the country were coming more and more alive to the necessity and the sdom of making appointments for chemists more attrace to the best qualified. In order to secure better nuneration and conditions of appointment, chemists re urged to do all in their power to render themselves prepared for such opportunities as came their way. The Institute was ready to help them to secure suitable appointments, and endeavoured to encourage the employment of the competent. The situation was far more promising than at the time of the Armistice; over 530 chemists whose names had been on the Appointments Register had now no further need of this assistance.

The Institute had been in communication with several of the Whitley Industrial Councils for industries on which chemistry had a bearing, and although under the constitution of the Whitley Councils no provision was made for the direct representation of chemists, several were acting as employers' representatives, and the Councils were prepared, where occasion rose, to turn to the Institute for assistance. The roll of the Institute was steadily increasing, numbering nearly 3000 Fellows and Associates and over 500 Registered Students. The Council were engaged in work of reconstruction: remodelling the bylaws, providing for district representation on the Council, and revising the regulations for admision to the membership. They had taken up the question of securing representation of chemistry in the Ministry of Health, with the satisfaction of seeing Sir William Tilden appointed a member of the Council on Medical and Allied Services, and Dr. J. F. Tocher appointed Chemist to the Scottish Board of Health. Attention was being given to the continued production by British manufacturers of glass apparatus, chemical reagents, and other laboratory requirements which hitherto were obtained mainly from Germany and Austria.

Jointly with the Institute of Metals a Committee was engaged on questions affecting the status and organisation of chemists and metallurgists with the Navy, Army, and Air Force. Mention was made of the activity of the Local Sections, and of the help rendered by them and the Honorary Corresponding Secretaries Overseas in the work of the Institute.

The Officers and Members of Council for the year 1920-21 were elected as follows:—

*President*—Sir Herbert Jackson, K B E., F R.S.

*Vice-Presidents*—Horatio Ballantyne; Sir James Johnston Dobbie, LL.D., F.R S; Ernest Mostyn Hawkins; Gilbert Thomas Morgan, D Sc., F.R.S.; Sir Robert Robertson, K B.E., F.R S.; George Stubbs, O.B.E.

*Hon. Treasurer*—Edward William Voelcker, A R S M.

*Members of Council*—Walter Ernest Adeney, D.Sc. A.R C.S.I. (Dublin); William Bacon, B Sc. (London); Edward Charles Cyril Baly, O B.E. F.R S. (Liverpool); Oscar Lisle Brady, D Sc. (London); Francis Howard Carr (Nottingham); Alfred Chaston Chapman (London); Allin Cottrell, M.Sc. (Gretna); Alexander Charles Cumming, O B.E., D Sc. (Edinburgh); John Thomas Dunn, D.Sc. (Newcastle); Lewis Eynon, B.Sc. (London); Alexander Findlay, M.A., D.Sc., Ph.D. (Aberdeen); George Watson Gray (Liverpool); Frank William Harbord, C.B.E., A.R S M. (London); Charles Alexander Hill, B.Sc. (London); Patrick Henry Kirkaldy (London); Joseph Henry Lester, M.Sc. (Manchester); William Macnab (London); Samuel Ernest Melling (Manchester); Gordon Wickham Monier-Williams, O B.E., M C., M.A., Ph.D. (London); Andrew More, A.R C.S. (London); Frederick Mollwo Perkin, Ph.D. (London); George Henry Perry, M.B.E., B.Sc., A.R.C.S. (London); Benjamin Dawson Porritt, M.Sc. (Edinburgh); Francis Martin Potter, M B.E., B.Sc., A.R.C.S (London); John Rogers, O B.E. (Glasgow); Ernest Woodhouse Smith, D.Sc. (Birmingham); William Maurice Gathorne Young (Doncaster).

RADIUM IN CZECHO-SLOVAKIA.—According to the Czecho-Slovak Labour Minister Czecho-Slovakia has in its possession at present the largest quantity of radium of any country, viz., 2 grms., worth Kr. 20,000,000.—*Reuter's Trade Service.*

## NOTES.

LORD EMMOTT ON NATIONALISATION.—"The State never saves, but, like Oliver Twist, always wants more," and "the essence of nationalised industry is that there is *no saving*," said Lord Emmott at the Guildhall *recently*, when he spoke at considerable length on the question of nationalisation. While the axiom "like Oliver Twist" comes so opportunely to one's mind in describing the *voracious propensities of an individual, it would appear* that it has been left to Lord Emmott to discover a super Oliver Twist in applying the designation to the Government. Yet, in view of the agitation now going on in regard to the question of the nationalisation of the coal mines, the full report of Lord Emmott's address, which is given in the February issue of the *Industrial League and Council's Journal*—a copy of which has been sent to us for review—is intensely interesting. The crux of the matter, says his Lordship, is that saving is absolutely essential to our financial existence. Before the war this country saved £400,000,000 a year, and I must point out that saving is essential to progress, otherwise there is no means of increasing the labour available or increasing the means of employing the labour available. Now, the essence of nationalised industry is that there is no saving. Profits have either to go to the National Exchequer or in the reduction of the prices of commodities. The State never saves, but, like Oliver Twist, always wants more. Remember that the railways in other countries—the chief thing nationalised hitherto—have always borrowed for new enterprises. In regard to coal mines, new shafts have been sunk largely out of the reserves and savings of coal owners. If the coal mines are nationalised, in all probability the State will borrow for new sinkings, and if other industries are going to be nationalised there will be no one left to save except those who own Government *Bonds and do not have to spend all their interest.* I am certain there must be enormous crippling of saving if we resort to nationalisation. The address by Lord Emmott, however, is by no means the predominating feature of this month's issue of the *Industrial League and Council's Journal*. As is well known, the Rt. Hon. J. H. Whitley, M.P. (Deputy Speaker of the House of Commons), and the Rt. Hon. G. H. Roberts, M.P., are the Joint Presidents of the Industrial League and Council, the activities of which are extending to all parts of the country, the fundamental principle of the movement being to create and foster better relations between employers and employed. While the journal gives but an epitome of the activities of the League, it provides a splendid reflex of the valuable work the organisation is doing in helping to solve, not only the industrial problems which confront the nation, but in endeavouring to create happier conditions and harmony in industry as a whole. When the Rt. Hon. G. H. Roberts said at Birmingham but a few days ago, "the Industrial League and Council deserves Government recognition for the work it is doing," there is no doubt, notwithstanding the fact that he spoke as President of the League, that he voiced the opinion of a vast number of leaders of industry, and the sentiment is one which we should like to endorse. Sir Woodman Burbidge, Bart., C.B.E., a director of Messrs. Harrod's Stores, whom everyone will admit is a keen business man, has *written the front page article in the journal*, and says, in reference to the League:—"I cannot appreciate too highly its work and the laudable objects it sets out to achieve." The publication also contains an interesting lecture on Scientific Management, by Mr. Maurice G. Liverman; a complete *résumé* of the work of the Whitely Council in the Cocoa, Chocolate, and Jam Industries, by Mr. Sydney W. Pascall; an address on Higher Education and Commerce, by Dr. Russell Wells, a member of the Senate of London University; and notes on the Industrial Situation, by Mr. H. G. Williams, M.Sc., to and affords interesting reading and is a credit organisation of the League, which has its headqua 83, Victoria Street, S.W. 1.

## MEETINGS FOR THE WEEK.

*Monday, March* 8.

Royal Institution, 3. "Modern Development c Miner's Safety Lamp," by Sir John Cadman.

Biochemical Society, 5.30. (Annual Meeting).

Royal Geographical Society, 5.

*Tuesday, March* 9.

Royal Institution, 3. "British Ethnology," by Arthur Keith.

Institution of Civil Engineers, 5.30.

*Royal Photographic Society*, 7.

*Wednesday, March* 10.

Royal Institution, 3. "Petroleum and the War," John Cadman.

Royal Society of Arts, 4.30. "Gas in relation to trial Production and National Economy," by Thomson.

Geological Society, 5.30.

*Thursday, March* 11.

Royal Society, 4.30. "The Pressure upon the Pc Metallic Arcs, including Alloys and Composite by W. G. Duffield, T. H. Burnham, and A. A. "Further Experiments on the Variation of Length of the Oscillations generated by an Valve due to Changes in Filament Current," by Vincent. "The Theory of the Katharometer H. A. Daynes. "The Process of Diffusion thro Rubber Membrane," by H. A. Daynes.

Royal Institution, 3. "The Upper Air," by Lieut Ernest Gold.

Institute of Metals, 4. (Annual Meeting).

Institution of Electrical Engineers, 6.

Optical Society, 7.30.

*Friday, March* 12.

Royal Institution, 9. "String Figures," by W. W. Ball.

Physical Society, 5.

*Saturday, March* 13.

Royal Institution, 3. "Positive Rays," by Sir Thomson.

Ex-Sapper, M.M., age 34, married, Gram and Technical School education, Diplomas 1st class, C cates in Inorganic Chemistry and Metallurgy, with thirteen ye steel works laboratory, including apprenticeship as Chemist, appointment as Assistant Metallurgical Chemist or suitable po —Address, Carter, 137, Bath Row Birmingham.

Ex-Soldier (20), single, Matriculated, t years' experience in Analysis of Foods, Drugs, Oils Soaps, Metals, and Coal, desires Position as Assistant Anal Works Chemist.—Address, X. S., CHEMICAL NEWS Office, 16, castle Street, Farringdon Street, London E.C. 4.

EVENING CHEMICAL WORK—Lat tory, Clerical, or Teaching—wanted by Lady with B.Sc. tr and works experience. Accustomed to library "digging."—Ad E. W., CHEMICAL NEWS Office, 16, Newcastle Street, Farri Street, London, E.C. 4.

Young Lady seeks Position in Analytical oratory. Good experience.—Address, Y. L., CHEMICAL Office, 16, Newcastle Street, Farringdon Street, London, E.C.

Young ex-Service Man (21), Matric dis tion Chemistry, Mathematics, desires opening in Analyt Testing Department of Manufacturing Chemist (Pharmaceuti

HE CHEMICAL NEWS.

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## IE USE OF HALOID CYANIDES FOR THE PURPOSE OF GOLD EXTRACTION.*

By T. B. STEVENS and C. E BLACKETT.

this paper it is proposed to review the use of the haloid npounds of cyanogen for the purpose of gold extraction the light of recent experimental work. During the past years such great advances have been made, both in the sting of refractory gold ores and the treatment of them y by fine grinding and air agitation with cyanide solu- n, that the use of the haloid cyanides has to a great ent been abandoned, although previously they played a ost interesting and valuable part in the development of : cyanide process. From the results of the work which have done we have formed the opinion that with tain classes of ore, the nature of which will be cribed, cyanogen bromide can still be used to advan- e even with our present knowledge of the cyanide pro- s. The reasons for the failure of the iodide and the oride will also be dealt with.

### *Historical.*

Shortly after gold was discovered at Kalgoorlie, the ords of the patent offices contained many specifica- ns for utilising the solvent action of the haloid com- unds of cyanogen on gold and gold-bearing minerals, : of this large number of potential processes there is y one which has been of any practical use. The patents ich were taken out may be divided into three classes, : first containing those which attempt to dissolve the d by what we may term a "Corrosive" action in the ne way as chlorine was used in the chlorination process. very early and somewhat humorous mixture, as judged present day knowledge, is given in the specification of rkes as follows (British Patent No. 17,033, December 10, 37):—

'4 lbs. bromine, or an equivalent weight of a salt of mine, such as crude bromine of sodium or bromine solved in an alkali;

'1 lb. of cyanide of potassium or of sodium or other mide;

'1 lb. of chromic acid or bichromate of potash and phuric acid in equivalent proportions;

'40 gallons of water."

The second class is represented by the patent (Victorian tent No. 11,538, July 23, 1894) of Gaze and Field, who empted to dissolve gold by the use of a solution con- ning a haloid cyanide alone. This class was not suc- sful because the proposed solvent did not dissolve the d. The third and successful class is represented by the ent (West Australian Patent, No. 601, of 1894) of lman and Teed, who used a solution containing an aline cyanide, together with a smaller quantity of a oid cyanide, the latter being used as a mild oxidising ent.

The first satisfactory commercial use of cyanogen mide was made at the Hannan's Brownhill mine by . Diehl in 1898 under the Sulman and Teed patents. rly attempts to use the process on a commercial scale re failures, and it was due to the extensive research work of Diehl that the best method of using the solvent and the requisite physical condition of the ore were discovered. After this had been done several of the larger plants at Kalgoorlie were equipped to use it, and continued to do so until the grade of ore fell so low as to make the additional cost of chemicals unprofitable.

### *Use of Cyanogen Bromide.*

*Nature of Solvent.*—The only haloid compound which has been put to any commercial use is cyanogen bromide, but a solution of it alone as patented by Gaze and Field is no more a solvent for gold than is the oxygen which enters into Elsner's well-known equation. If, however, it is mixed with a solution of an alkaline cyanide in certain proportions and under certain conditions, it forms a much more rapid solvent than a plain solution of an alkaline cyanide does. This fact is easily demonstrated by Sulman's experiment (*Proc. Chem. Metal. Soc. of South Africa*, i., 112), in which pieces of gold leaf are floated on cyanide solution in two separate dishes, to one of which is afterwards added a little cyanogen bromide, which causes the gold leaf to dissolve almost instantaneously as compared with the slow action of the cyanide in the other vessel.

Sulman and Teed in their patent specification give the following equation to explain the solution of the gold, and state that no oxygen is required, in fact the bromine takes the place of the oxygen—

$$CNBr + 3KCN + Au_2 = 2KAu(CN_2) + KBr.$$

The increase in solvent power due to the addition of cyanogen bromide is very clearly explained by Bertram Blount (*Trans.*, iii., 247) as follows:—"The bromine is essentially to provide some negative element to combine with the potassium which would otherwise go free. It must be provided with some other element which will combine with it and form a suitable compound. Such a compound in this case is the bromide, and the way in which it acts is precisely the same, to my mind, as the reaction of the oxygen in the ordinary cyanide process."

Whilst the solution of gold by the mixed solution of cyanide is a very simple matter in the laboratory, a large number of complications are encountered when it is used on a commercial scale. The patentees who first published the process do not appear to have been conversant with the fact, or, if they were, they did not disclose it, that a solvent consisting of the mixed cyanides is a short-lived one, and that a comparatively rapid reaction commences as soon as the mixture is made, which results in the de- composition of both substances, and gives products which are quite useless for the purpose of dissolving gold. This reaction, which we believe was first published by Alfred James (see Alfred James, "Cyanide Practice," p. 136), is as follows: —

$$CNBr + 2KCN + H_2O = KCNO + KBr + 2HCN.$$

The following experiment shows the rate of decomposi- tion when no ore is present. The solution contained four

| Time. | KCN per cent. | CNBr per cent. |
|---|---|---|
| Freshly mixed | 0·218 | 0·049 |
| After 30 minutes | 0·209 | 0·029 |
| „ 1 hour | 0·198 | 0·019 |
| „ 2 „ | 0·188 | 0·011 |
| „ 4 „ | 0·176 | 0·003 |
| „ 8 „ | 0·174 | Trace |

parts by weight of potassium cyanide to one part of cyanogen bromide, these being the proportions which have been found most efficient for ore treatment; no other salts were present. The decomposition is considerably accelerated by heat as shown by the following results, which were obtained by taking three portions of the same solution and allowing them to stand at different tempera- tures for one hour.

* Read before the Institution of Mining and Metallurgy, February 1920. From the *Bulletin of the Institution of Mining and Metal- lurgy*, February, 1920.

| Temperature. | KCN per cent. | CNBr per cent. |
|---|---|---|
| Solution freshly mixed | 0·197 | 0·116 |
| 1 hour at 60° F. | 0·148 | 0·067 |
| „ 100° F. | 0·080 | 0·010 |
| „ 140° F. | 0·067 | Nil |

From this will be seen that cyanogen bromide can only be described as a rapid cyanicide, and great care must therefore be exercised in the quantity which is used, otherwise such a great proportion of the alkaline cyanide will be decomposed that the extraction will be poorer than could be obtained by using the same amount of alkaline cyanide alone.

The compound cyanogen bromide solvent is a very powerful one, but as we have shown it is a very short lived one even under the most favourable conditions, and in order to use it to the best advantage, the haloid compound should be added almost continuously in the same way as fresh oxygen has to be added to plain cyanide solutions. For this reason when treating high grade ores it has become usual to divide the cyanogen bromide into several portions, which are added at intervals of three or four hours during the agitation.

*Nature of Ore Treated.*—Owing to the instability of the solvent it is also necessary that the gold which is to be dissolved must be thoroughly exposed to it; in other words, the ore must be ground so finely that the gold particles are exposed to the solvent on practically all sides. If we imagine a flake of gold enclosed between the cleavage planes of pyrites so that only one edge of it is exposed, the solvent will have such a small area for attack in comparison to the weight of the particle, that it will have lost its power before all the gold has dissolved, and in such an instance a solution of plain cyanide would give a much better ultimate result, although it would take very much longer to accomplish. This is why cyanogen bromide has never been successfully used in the treatment of sand or concentrate by percolation; and also why no ore has yet been successfully treated which has not been ground to slime. In this instance we would describe slime as a product passing through a 150 mesh sieve (I.M.M. Standard), the proportion of colloids present being quite immaterial.

When the cyanogen bromide process was first introduced, a great deal was written about the possibilities of treating refractory gold ores, such as those containing arsenic, antimony, and copper, but no records exist to show that these hopes were ever realised. As ores of this nature usually have their gold value contained in the mineralised portion it is easy to see now why so many failures took place. Ore which is to be prepared for treatment by this process must first have all gold which is too coarse to dissolve rapidly removed either by amalgamation or concentration, and it is also necessary to remove by concentration any mineral which contains gold in such a condition as not to be effectively exposed. With regard to the tellurides of gold these are dissolved much more rapidly than they are by the simple cyanide solution, the time of agitation required often being only hours as compared with days required for the same extraction with the simple solution. Fortunately, the tellurides are very friable, so that there is no difficulty in reducing them to the desired state of division in the process of crushing the ore.

In order to demonstrate practically the short life of the solvent and the impossibility of dissolving gold which is not thoroughly exposed, we have made percolation tests on sand charges comparing cyanogen bromide and plain cyanide. Two leaching vats were constructed which were each 5 ft. deep and 3 in. in diameter. They were built in sections, each section being 1 ft. long, and they were joined together with rubber joints in order that the vat could be readily taken to pieces and the sand from each foot of depth sampled and assayed. Sand was prepared by crushing sulpho-telluride ore in the stamp battery through a 30 × 30-mesh screen, and the bulk of the slime and concentrate was subsequently removed by pann the sand being dried in the sun. A grading analysis showed that 18 per cent would remain on an 80-1 standard sieve; it could therefore be regarded as san good physical condition for treatment by percola Each vat had a capacity of 10,000 grms. of sand, w was first saturated with water, 2200 cc. being added b any commenced to leach through. This moistenin the sand contained in the vat was done in order to as closely as possible the manner in which sand vats filled on a practical scale. The contents of the vats then treated as follows, each receiving the same am of solution :—

(*a*) Was treated with simple cyanide, of which leaching solutions were employed of a volume of 220 each, and containing 0·2 per cent KCN. Lime was m with the sand before charging the vat at the rate of 2 per ton. Each leaching solution was sufficient to disp the water which had been used to moisten the cha After the first solution had been put on 2200 cc. of placed water were allowed to leach off slowly, and leaching cock was then closed and twenty-four h contact was given with the first solution. At the en the time of contact, the charge was allowed to leach and stand for twenty-four hours to allow it to bec thoroughly aërated. The second solution was then pu and the 2200 cc. of the first solution allowed to l through. The leaching cock was then closed and twe four hours contact given with the second solution. contents of the vat were finally drained dry, washe remove soluble gold, dried, sampled and assayed. total time of treatment was four days.

24 hours contact with first solution.
24 „ leaching dry.
24 „ contact with second solution.
24 „ draining and washing.
—
4 days total time of treatment.

(*b*) The treatment was with cyanide and cyano bromide in the absence of protective-alkali. The rea for using no alkali will be explained subsequently. T solutions were used of the same volume as in (*a*), containing 0·2 per cent KCN and 0·05 per cent CN The first solution was put on, and when the 2200 cc. water used to moisten the contents of the vat had leac through, the leaching cock was closed and forty-ei hours contact given. The first solution was displa with 2200 cc. of the second solution, the leaching c being opened until 2200 cc. of the first solution l leached through. This second solution was given fo eight hours contact with the sand, after which it washed free from dissolved gold, dried, sampled a assayed. In this experiment, unlike the first one, charge was not allowed to leach dry and stand, as it w assumed that aëration could be of no benefit when us cyanogen bromide. The total time of treatment was f days.

48 hours contact with first solution.
48 „ „ „ second solution.
—
4 days total time of treatment.

The following are the assay results :—

Assay of original sand, 85·1s.

| Position in vat. | Residue using cyanogen bromide. | Residue using plai cyanide. |
|---|---|---|
| 1st foot | 31·9 shillings | 31·4 shillings |
| 2nd „ | 42·2 „ | 32·5 „ |
| 3rd „ | 48·4 „ | 35·9 „ |
| 4th „ | 49·8 „ | 38·6 „ |
| 5th „ | 52·3 „ | 42·9 „ |
| KCN consumed | 1·1 lb. per ton | 0·8 lb. per ton |

The results show practically what a short life cyanog

ide has. The value of the top layer is nearly the in both experiments, but the lower layers in the ogen bromide experiments are all considerably higher they are in the plain cyanide one, despite the fact in the former more cyanide was consumed per ton. explanation of this marked difference is due to the ogen bromide solvent being decomposed before it has lled through 1 ft. of sand, and in decomposing it has oyed so much of the alkaline cyanide as to make its gth inferior to that contained in the other vat; as a quence the extraction of the gold has suffered con- ably. We have abundantly proved, by an enormous ber of experiments, that unless the ore be very finely nd so as to expose the gold particles and also to enable solvent to be brought in intimate and rapid contact them by agitation, there is no benefit, but an absolute ment, in using cyanogen bromide, and prolonged ment with plain cyanide will always give superior ts. The experiment which has been cited may be ised from the point of view that the extraction ined by either method was not a commercial one, but would point out that ore of a high grade and refractory re was specially taken for this experiment in order to e the differences more striking. With ore of lower e and of less refractory nature similar results have obtained, but the differences are, of course, not so t.

om these experiments it may be inferred that cyanogen nide can be used to advantage on two classes of ore. first class includes ores which contain minerals such e tellurides, which are more soluble in this solvent they are in plain cyanide. The second class includes with which a rapid solution of the gold is necessary rder that other substances contained in the ore shall have time to dissolve and foul the solution.

(To be continued)

## /ULFENITE—ITS CONCENTRATION AND SEPARATION FROM BARITE.*

J. P. BONARDI, Assistant Chemist, U.S. Bureau of Mines.

(Concluded from p. 111).

### *Procedure of Tests.*

testing an ore for ore dressing possibilities there is bably nothing so enlightening as screen classification, ay of products, and experimentation upon them by dif- nt metallurgical processes. The use of the microscope his connection also cannot be over-emphasised. (The of the microscope for use in connection with an ore ssing problem is described in another paper, "Approxi- te Quantitative Microscopy of Pulverised Ores," by H. Coghill and J. P. Bonardi, *Tech. Paper* 211, eau of Mines).

Accordingly, the so-called *middling material*, as re- ved, was first screened into six products as shown in ble I.

TABLE I.—*Screen Analysis (Feed Assayed* 5·50 *per cent* Mo).

| | Per cent Wt. | Per cent Mo. | Content Mo. Grms. |
|---|---|---|---|
| −10+20 .. | 13 74 | 2·50 | 0·344 |
| −20+28 .. | 14·40 | 3·00 | 0·432 |
| −28+35 .. | 15·65 | 3·20 | 0·473 |
| −35+48 .. | 17·35 | 9·67 | 1·678 |
| −48+65 .. | 22 50 | 7·40 | 1·665 |
| −65 .. | 16 36 | 5·42 | 0 887 |
| | 100·00 | 5·50 | 5·48 |

These screened products were examined separately under the microscope to ascertain the degree of locked wulfenite grains in order to determine whether the material would be classed as a true middling, and would need any further crushing to liberate the wulfenite before submitting to further concentration. The treatment of middlings has followed, as a rule, two well-beaten paths: reground and returned to ore stream, or returned to ore stream without regrinding. This results often in mixing two products of widely different grades; the ore itself being perhaps of low content and the middlings of relatively high content, as regards the mineral to be saved. This fact must be borne in mind in studying the treatment to be given the material under discussion. On examination under the microscope the plus 20-mesh was found to be the only screen product containing any locked material, and this was only small in amount. That the material as received was not a true middling was readily seen, as the term "middling" is applied to a crushed product, the individual grains of which are composite; that is, they contain, attached to or imbedded in the gangue, particles of valuable mineral. Theoretically, no free grains of valuable minerals should be present, but in practice there will always be a varying proportion of such grains. The proportion of locked grains in this so-called middling material, being of such small proportion to the free grains, would readily classify it as not a true middling.

Next, in order to try out the separation of the wulfenite from the barite in the various screen products, as shown by the screen analyses, as well as on the unclassified material as received, the different sized products and unclassified material were submitted separately to a laboratory experimental size Wilfley table. Since the screen products were dry-sized between small limits, the separation of the free mineral grains of wulfenite from the gangue barite, in which the difference of specific gravity exceeds two units, should be an easy matter. The results of a few simple tests made on the small experimental size Wilfley table are give in Table II. The material in each run was passed but *once* over the table, and only the concentrates of each were collected, weighed, and assayed.

TABLE II.—*Concentration Tests on Small Experimental Size Wilfley Table.*

| Run. | Mesh. | Wt. taken. Grms. | Per cent Mo. | Wt. of conc. Grms. | Per cent Mo in conc. | Per cent recovery Mo. |
|---|---|---|---|---|---|---|
| 1 | Unclassified material | 500 | 5 50 | 28 | 14·17 | 14·45 |
| 2 | −10+20 (*a*) | 500 | 2·50 | none | — | — (*b*) |
| 3 | −20+28 (*a*) | 500 | 3 00 | none | — | — (*b*) |
| 4 | −28+35 (*a*) | 500 | 3·20 | 50 | 9·40 | 28·80 (*c*) |
| 5 | −35+48 | 450 | 9 67 | 205 | 12·12 | 57·05 |
| 6 | −48+65 | 450 | 7·40 | 155 | 13·16 | 61·20 |
| 7 | −65 | 500 | 5·42 | 160 | 12·60 | 74·50 |

(*a*) The wulfenite crystals of these meshes being large, thin tabular, and flaky, rolled along over the table with the barite gangue, and no line of demarcation could be made between the minerals of different specific gravity.
(*b*) No separation.
(*c*) Poor separation.

Jigging of these sizes was not attempted, since the company submitting the wulfenite ore had not installed any jigs in the mill. Further, expert attention would, in all probability, be required in the successful operation of jigs treating material of such fineness; besides taking into consideration wulfenite which when occurring in an ore in square, tabular, and sometimes extremely thin crystals would cause trouble by not following the settling ratio of the specific gravity difference.

In the runs made, as indicated in Table II., the grade of concentrates in each case could have been bettered by cutting off a larger middling product, or by running the

* From *Journal of the Franklin Institute*, January, 1920.

concentrates that were collected over the table a second time. This was not deemed necessary when using the experimental machine, since only indicative results were desired.

Table II. clearly illustrates the fact that the large wulfenite crystals—greater than 35-mesh—in association with barite are not adapted to table work, since they have a tendency to roll along with the coarse barite gangue. Wulfenite grains or crystals in this case, being approximately the same weight, due to their thin and tabular structure as barite grains, did not have an opportunity to arrange themselves on the table according to their specific gravity differences.

In order to make a comparison of the sized runs with an unclassified ground feed, a sample of the original material was ground dry in a ball mill to pass 80-mesh; 2000 grms. of this minus 80-mesh material was run over the experimental table *once*, as in runs made with screened sizes. Table III. represents the results obtained.

TABLE III.—*Runs made on Minus 80-Mesh Material on Wulfenite Barite Ore passed Once over Table.*

| Sample | Wt. in grms. | Per cent Mo. | Per cent $BaSO_4$ | Per cent recovery Mo. | Per cent recovery $BaSO_4$ |
|---|---|---|---|---|---|
| Head . | 2000 | 5·50 | 52·20 | — | — |
| Conc. . | 508 | 14·32 | 21·14 | 66·20 | 10·28 |
| Mid. .. | 338 | 5·76 | 51·10 | 17·72 | 53·01 |
| Tails .. | 726 | 1·86 | 76·20 | 12·28 | 16·55 |
| Loss .. | 428 | 0·97 (*a*) | 49·20 (*a*) | 3·80 | 20·16 |
| Footing | 2000 | — | — | 100·00 | 100·00 |

(*a*) Calculated.

Table III. clearly illustrates the following points:—

1. That crushing in this manner does not entail any great loss of wulfenite in the slime going to waste, since only 3·80 per cent Mo was unaccounted for.
2. That 66·20 per cent of the wulfenite can be recovered in a concentrate of marketable grade.
3. That barite can be successfully concentrated from wulfenite, since only 10·28 per cent of the total remained with the concentrate.
4. That the above tails and middling product respectively are of the same grade as the original milled ore and first middling produced, and, consequently, further recovery can be made by treatment.

The results of the experiments as performed and given in Tables II. and III. clearly illustrate the fact that in the wet separation of wulfenite from barite, when using tables, particular attention must be given to the ore-dressing method adopted, and to the degree of grinding. Grinding at least through 48 mesh would be recommended for this class of material as Table II. indicates.

In order to determine approximately the highest grade of concentrate that can be produced from this barite middling material, 500 grms. of the concentrates, assaying 14·32 per cent molybdenum produced in experiment as given in Table III., were carefully re-run several times over the Wilfley table with the results given in Table IV. No slime was produced in this treatment, so the products were easily collected and recovered.

TABLE IV.—*Concentration Test for High-grade Product.*

| Sample. | Weight in grms. | Per cent Mo. | Per cent recovery Mo. |
|---|---|---|---|
| Head .. .. | 500 | 14·32 | — |
| Conc. .. .. | 268 | 17·85 | 67·00 |
| Tails .. .. | 230 | 9·96 | 32·00 |
| Loss .. .. | 2 | — | 1·00 |
| | 500 | | 100·00 |

The above content of 17·85 per cent molybdenum in the concentrate represents 26·77 per cent $MoO_3$. Theoretically a concentrate consisting entirely of pure wulfenite contains 39·23 per cent $MoO_3$, so the concentrate represents a grade of 68 per cent wulfenite. This would then in all probability repr the highest grade of concentrate that could be obtain treating such an unclassified feed of this material. chemical analysis of this concentrate (Table V.) further emphasise this point.

TABLE V.—*Analysis of Concentrate.*

| | Per cent. |
|---|---|
| $MoO_3$ .. .. .. .. .. .. | 26·93 |
| PbO .. .. .. .. .. .. | 52·15 |
| $Fe_2O_3$ .. .. .. .. .. .. | 1·03 |
| $Al_2O_3$ .. .. .. .. .. .. | 1·19 |
| $SiO_2$ .. .. .. .. .. .. | 3·30 |
| $V_2O_5$ .. .. .. .. .. .. | 0·65 |
| $P_2O_5$ .. .. .. .. .. .. | 0·17 |
| $As_2O_5$ .. .. .. .. .. .. | 0·90 |
| $BaSO_4$ .. .. .. .. .. | 12·76 |
| Cu .. .. .. .. .. .. | none |
| Total determined .. | 99·08 |

The above analysis indicates that theoretically fu concentration could be performed by elimination of 12·76 per cent barite and the little other gangue stil maining with the concentrate; but in practice, if this attempted, close sizing of the feed would be requ Other lead minerals than wulfenite, vanadinite, mime pyromorphite, are indicated by the excess amount of oxide that is required to combine with the above elem given in the analysis. The presence of both anglesite cerussite in the concentrate was later confirmed, but in traces.

*Flotation Tests on Barite "Middling" Material.*

On this particular ore, ground through 80-mesh, flota was attempted after giving it a sulphidising treatm The material was easily sulphidised by heating for a s period within a dilute sodium sulphide solution, in portion of 10 pounds $Na_2S$ to 1 ton of ore with a ratio of 1 : 1. In treating the sulphidised material flotation machine it was found on several trials various oil mixtures and variations of factors, that barite and wulfenite would come over with the frot approximately the same proportion as contained in feed. In tracing down this cause it was found that was due to the fact that part of the barite and the silic gangue matter was iron stained, and as this iron-stai material was easily sulphidised it was carried along with the sulphidised wulfenite, and consequently no mar separation could be made. Also, it was found in forming the sulphidising treatment that a consider amount of wulfenite was rendered soluble, and, co quently, could not be accounted for in assaying the ducts. The results did not warrant doing any fur work by flotation; therefore this was discontinued.

*Conclusions as to Laboratory Tests.*

As the experimental tests were of necessity made o laboratory scale and on very small samples of ore, results obtained on this particular ore must be conside only as indicative of what might be expected from treatment of commercial quantities of ore on machine standard size, where the proper conditions for separa can be better controlled. The results from the sr laboratory machine are at the best only indicative, should be regarded only in this light. Flotation was a factor on the ore treated.

The results found with the experimental Wilfley ta indicate that wulfenite can be concentrated from a ba gangue with very promising results, since on the sn laboratory machine used a recovery of between 60 and per cent of the molybdenum could be effected by pass the material only *once* over the table. It must be

ıbered also that a recovery had previously been made he original milled ore of over 60 per cent, so that the *tional increase obtained from the middling material,* n ground through 80-mesh and with no further classi ion, *gives a total recovery of over 85 per cent.* This very on material that had received no special classi- ion, outside of grinding, emphasises further the ɔtability of wet concentration methods to wulfenite , even with such high specific gravity gangue as te. By a slight rearrangement of the mill circuit enite should be as readily separated from barite as ɔ gangues of a lower specific gravity.

ı conclusion, the author wishes to express his apprecia- and gratitude to Dr. R. B. Moore, Superintendent of U.S. Bureau of Mines mining experiment station of den, Colorado, for his valuable suggestions throughout progress of the work.

## :HE SEPARATION OF ZIRCONIUM AND TITANIUM AS THE PHOSPHATES.

By JAMES BROWN and H. T. MADDEN.

ı previous paper (*Journ. Am. Chem. Soc.*, 1917, xxxix., 8) one of us made use of the Hillebrand method ınalysis of Silicate and Carbonate Rocks," U S. Geol. vey, *Bull.* 422, 1910, 141) of separating zirconium n titanium by precipitation of the former by use of lrogen peroxide and alkaline phosphate in a faintly d solution. The titanium, when large in amount, was *ermined* as a difference or by the permanganate method, l by the colorimetric method when small amounts were sent. The work recorded in the present paper was lertaken with the object of making a direct gravimetric ermination of the titanium in the filtrate from the :onium phosphate precipitation.

The standard solutions employed were prepared from re potassium zirconium fluoride ($K_2ZrF_6$), and from pure tassium titanium fluoride ($K_2TiF_6$), respectively. The re salts of commerce were recrystallised from boiling ter several times, and were then converted into the lphates by evaporation with sulphuric acid in a platinum ıh until all fluorine was expelled. The residues were ated with water. Qualitative tests showed the absence iron, aluminia, manganese, and rare earths from both lutions.

### *Standardisation of Solutions.*

The solutions of zirconium sulphate and of titanium lphate thus prepared were standardised by precipitation ith ammonia, and ignition to the dioxide in the ıal way.

From other portions of the zirconium solutions the base as precipitated as the phosphate, by disodium or diammonium phosphate, the solution containing 1–2 per cent r volume of sulphuric acid. The zirconium phosphate as filtered off, washed, ignited, and converted to the oxide as follows:—It was fused with sodium carbonate, e melt leached with water, and the insoluble residue ssolved either in hydrochloric acid or by fusion with dium bisulphate and subsequent treatment with a dilute ılution of sulphuric acid. The zirconium phosphate ıowed marked decrepitation during ignition. The zir- ɔnium was precipitated with ammonia, and weighed as $rO_2$ after ignition. The zirconium dioxide thus obtained om the phosphate corresponded in each case with the :andard obtained by treating the original solution with mmonia. The amount of zirconium dioxide involved aried from 0·1608 to 0·3216 grm. In view of the qualitative nd quantitative checks thus obtained the zirconium sulhate solution was considered free from interfering bases.

The solution of titanium sulphate, standardised by precipitation with ammonia, and ignition to titanium dioxide, as further standardised as follows:—

Portions of the solution containing 1—2 per cent of sulphuric acid by volume were precipitated by use of *disodium or diammonium phosphate, filtered, ignited, and* weighed. The titanium phosphate thus obtained was of variable composition. It was therefore converted to the dioxide as with zirconium, and weighed as titanium dioxide. The dioxide thus obtained corresponded to the standard obtained by use of ammonia directly with the original solution. The titanium dioxide used varied from 0·1124 to 0·5726 grm.

As a further check on the titanium solution titanium was determined by reduction with zinc and sulphuric acid, addition of an excess of ferric sulphate, and titration of the reduced iron salt by use of permanganate (Newton, *Am. Journ. Sci.*, 1908, [4], xxv., 130). The results thus obtained agreed very well with the standard obtained by use of ammonia alone, and the titanium solution was judged free from interfering bases.

### *Separation of Zirconium and Titanium.*

Measured amounts of the solutions of zirconium and titanium sulphates were mixed and made acid to the extent of 1—2 per cent of free sulphuric acid by volume. An excess of hydrogen peroxide was added. A solution of disodium or diammonium phosphate was added in excess, and the solution allowed to stand over-night. The precipitated zirconium phosphate was filtered off and washed with water containing a few drops of sulphuric acid and hydrogen peroxide. The zirconium precipitate is coloured yellow by titanium. To remove this titanium we proceeded as directed by Hillebrand (*loc. cit.*) by fusing with sodium carbonate, leaching, and redissolving by fusion with sodium bisulphate and action of dilute sulphuric acid. The zirconium was reprecipitated by hydrogen peroxide and phosphate, allowed to stand, filtered, and washed. In some cases this second zirconium precipitate contained small amounts of titanium, which were removed by repeating the above treatment.

The zirconium phosphate precipitated was converted to zirconium dioxide, as in the standardisation, and weighed as such. The results for the zirconium are given in the table.

The combined filtrates from the zirconium phosphate precipitation were heated to get rid of the hydrogen peroxide. The volume of the solution was then adjusted so that the content of sulphuric acid was about 2 per cent by volume, and disodium or diammonium phosphate solution was added to assure an excess. The liquid was allowed to stand about one hour, and the precipitate filtered and washed. The precipitate was converted to titanium dioxide as in the standardisation, and weighed as such. The results are given in Table I.

Table I.

| $ZrO_2$ taken. Grm. | $TiO_2$ taken. Grm. | $ZrO_2$ found. Grm. | Error, Grm. | $TiO_2$ found. Grm. | Error. Grm. |
|---|---|---|---|---|---|
| 0·1287 | 0·0562 | 0·1282 | −0·0005 | −0·0556 | −0·0006 |
| 0·1287 | 0·0562 | 0·1281 | −0·0006 | −0·0559 | −0·0003 |
| 0·2594 | 0·0562 | 0·2588 | −0·0006 | −0·0560 | −0·0002 |
| 0·2594 | 0·1124 | 0·2592 | −0·0002 | −0·1120 | −0·0004 |
| 0·2594 | 0·1124 | 0·2585 | −0·0009 | −0·1118 | −0·0006 |
| 0·1287 | 0·1124 | 0·1284 | −0·0003 | −0·1121 | −0·0003 |
| 0·2594 | 0·0562 | 0·2591 | −0·0003 | −0·0556 | −0·0006 |
| 0·2594 | 0·0562 | 0·2592 | −0·0002 | −0·0558 | −0·0004 |
| 0·2594 | 0·1124 | 0·2589 | −0·0005 | −0·1121 | −0·0003 |

### *Summary.*

The separation of titanium and zirconium by the Hillebrand method is quantitative within the limits used in this work. The zirconium phosphate is converted to the dioxide, and gives accurate results. The titanium in the filtrate from the zirconium phosphate may be completely precipitated by the use of sodium or ammonium phosphate, but as this precipitate is of variable composi-

tion it should be converted to the dioxide to obtain quantitative results.—*Journal of the American Chemical Society*, xlii., No. 1.

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THE

## EXTRACTION AND PRODUCTION OF SUGAR FROM DIFFERENT VEGETABLE SOURCES.*

By ARTHUR R. LING.

(Concluded from p. 116).

DISCUSSION AT THE MIDLAND COUNTIES SECTION.

THE CHAIRMAN (Mr. G. R. Burdass) said that it seemed to him that cane produced twice the quantity to the acre as compared with beet. If they were to keep up their name as the producers of the greatest portion of sugar, they ought to encourage their Colonies in every possible way by giving them more up-to-date machinery and encourage them to produce the sugar required. Some small experiments had been made in the production of beet sugar, but he did not know of any instance where the farmer had thought fit to continue the production of beet; presumably, he had not found that it paid him so well as mangold wurzels, and, in view of the comparatively small acreage of the British Isles, he thought their land should be devoted to the production of food-stuffs; to a great extent they could do without sugar more easily than they could do without cereals. He did not think that there would ever be a large beet sugar industry in Great Britain, and if anything warranted their promoting sugar growing he thought it should be done in the direction of encouraging the Colonies, where sugar could be so much more easily grown.

Mr. JOHN M. LONES said that he had been particularly interested in the early portion of the paper dealing with the synthetic formation of sugar in plant life; in other words, nature's efforts to manufacture our sugars. It carried his mind back many years to a paper read by the late Dr. Sykes—an old friend of Mr. Ling's—wherein he described the development and formation of starch in the barley corn on similar lines to those adopted by Mr. Ling to-night. That paper was written in his early days, but he always remembered the interest he had at the time in Dr. Sykes' attempt to unlock nature's secrets. When they realised the immense tracks of land within the British Empire suitable for cultivation of either cane or beet, it reflected no credit upon their commercial enterprise to learn that prior to the war 96 per cent of our sugar was imported from various countries, and of this total 80 per cent was sent to them by European countries. For obvious reasons, this high percentage had been reduced since 1914, but from past experience they must recognise that if this matter were not taken up by this country with sufficient energy and thoroughness, what they still called "enemy countries" would strive to restore their former rate of production in the hope of making Great Britain again dependent on them. The Empire Sugar Supply Committee, with Mr. Ling as its Chairman, was working hard to check this tendency, and in doing so both he and his colleagues were performing, in the truest sense of the word, work of the highest national importance in attempting to make the Empire self-supporting regarding its sugar supplies. They were deserving of the strongest encouragement and support which could be given them, for their work, like all big undertakings, was crowded with difficulties. Mr. Ling had stated to-night, and had published the same evidence on more than one occasion, that this country could grow sugar beet equal in sugar-content and purity to that grown on the Continent, which made it the more disappointing to have to admit that so far the production of beet sugar had not met with the success it deserved here, chiefly owing to the want of technical knowledge on the part of the agriculturist, organised co-operation between farmer an[d] meagre support from the Government. Th[e] Ling's Committee showed that between the of sugar produced throughout the Empire consumed, there was a deficiency of 2½ This was serious and evidently under the [...] conditions would take some years to ma[ke] conditions to-day were not favourable, there scarcity of labour, new plant was costly, th[...] quired coaxing with ample security befor[e] their money. Mr. Ling was evidently castin[g] upon India to increase the Empire's supply it was possible by improved methods of c[...] recovery of the sugar and by making fuller of Gur, a substantial increase might be [...] was to be hoped that in India, as well as in the Empire, something would be done in Mr. Ling had referred to Spain as the [...] country growing cane, and having in [...] serious shortage and the improbability of good within the Empire within a reasonabl[e] one to enquire if efforts could not be mad[e] friendly nation like Spain to increase her cane. She was comparatively near to us, [...] tected from cold winds on the north by the having the benefit of the warm winds from ranean, her climate was a most favourable well-watered country with the sea washing its borders, her position gave her such natur[...] that surely something could be done to en[...] increase the world's sugar crop.

Mr. R. H. HOPKINS said that they had b[...] lot lately in the local Press about brewers He suggested that now, indirectly, the brew[...] grievance against the farmer who declined t[...] and preferred to grow mangold wurzels. would grow sugar beet, that might keep ou[...] beet sugar; the domestic consumer could beet sugar, allowing the brewer to use car[...] would like to ask Mr. Ling if he personally synthesis of cane sugar supposed to have be[...] by the Russian chemist Marchlewski in 18[...] effected by the condensation of potassium [...] chloracetyl-glucose. He believed that m[...] agreed that it was not a genuine synthesis. that a difference of opinion existed on the would like to know Mr. Ling's view on the [...]

Mr. W. SCOTT said that he had had som[e] sugar growing in the West Indies just abou[t] German sugar bounty was killing the tra[de]. Many planters gave up sugar planting in con[...] devoted their land to planting cocoa, cof[...] things, and no doubt at the present time island in which he lived was practically doi[...] the way of sugar growing. Mr. Ling ha[...] screen some slides of very crude plant. He thought that in the factory he was conne[...] plant was equally crude. They had a wate[r] three-roller mill, and had to carry the canes bullock carts. Because of the poor price sugar when shipped to England many of th[...] not trouble to crystallise out their sugar but form of syrup, for which there was a ready the natives. Without better organisation difficult for small planters of cane to bo[...] against the well-organised beet industry, and [...] to note from the paper that this matter was attention of the Government.

Mr. LING, replying to the discussion, mee[t]ing for their kind reception of his pa[...] brought with him a good deal of stati[...] but he found that the shortness of time ma[...] possible to deal with it. With regard to th[...] beet-growing, it had been suggested that th[...] be used in England for the production of ot[...]

* From the *Journal of the Institute of Brewing*, February, 1920.

stuffs rather than beet, but the beet crop was one to :h Germany owed not only its sugar industry, but, to rge extent, its agricultural industry, because no crop ned up the land so thoroughly as the beet crop. Beet iired deep cultivation, very much deeper than English ners were inclined to carry through, and their efforts at ducing beet had been carried out under the worst sible conditions. On the other hand, where the deep :ivation had been given, the roots in this country was al in every respect to those grown on the Continent. . Lones had pointed out that there were vast tracks of d in the British Empire which should be put under er cultivation for the growth of sugar. That was te true. The object of getting all those statistics ether, and the preparation of a report by the Special nmittee, had in view the filling up of that gap. The tistics showed that as an empire they were 2 500,000 is in production below their consumption. Mr. Lones d that sugar should be grown in Spain. There was a :d deal to be said for that, but Spain was not the British ipire, and the object of himself and his committee was get the sugar grown within the Empire. India was a ig way off, and he was afraid it would take years for : effort to produce Indian sugar to materialise. There re, however, on the West Coast of Africa vast tracks land very suitable for sugar-growing, and that work ght to be taken up. Egypt, also, used to be a sugar-iducing country to a greater extent than it was at :sent, and steps were already being taken to increase gar-growing there. The West Indies, however, had :at possibilities, and, if cultivated to the fullest extent, uld do something towards making up the deficiency, ugh they could not do everything. Mr. Scott had d the story of the way in which the sugar bounties killed : West Indian industry. He (he speaker) knew quite ll that that was the case. At the time when he (the eaker) served on that Committee, Sir Francis Watts, the iperial Commissioner of Agriculture for the West Indies, is in this country, and he agreed that the industry would ve died altogether if timely aid had not been given. He ite agreed with Mr. Allcock that there ought to be a gar industry in this country. The great essential was to t co-operation between the farmer and the sugar manu-cturer, and until they got that they would never have a gar industry. Whilst in no way opposing the establish-ent of a beet sugar industry in this country, he would int out that the main question was that in the Colonial mpire they could get at least twice as much sugar per re from cane as they could from beet. That was a atter well worth consideration. With regard to the ientific question that had been put, he was quite aware the experiments of Dr. Marchlewski, who claimed to ve synthesised cane sugar, but he had forgotten what e conditions were, and the experiment was discredited many people since it had not been found possible to peat it. But although a chemist could not repeat periments it did not follow that the original chemist as wrong, because it was often difficult to reproduce the onditions.

## BRITISH SCIENTIFIC INSTRUMENTS.

### Past and Present.

Before we deal with the present position of the scientific istrument industry, and with what it has learned during ie war, it will be useful to examine the position of the ade during the years immediately preceding 1914. The istruments produced can be conveniently divided into two iain groups; first, those articles which were required in irly large numbers and purchased by the general public uch as the opera or field glasses and aneroid barometer); condly, those instruments which were made in much naller numbers and for service in more strictly scientific ivestigations, instruments such as the large astronomical lescope and the torsion galvanometer.

So far as the first group is concerned—the popular group—this country was mainly dependent upon imports for an adequate supply. With regard to the second group, in which the articles did not lend themselves, chiefly on account of the limited demand, to bulk production, and in the manufacture of which individual skill of a high order was required, a very much larger proportion was produced at home.

*The Imported Instruments.*

It is not difficult now to see how our dependence upon Germany and France for ordinary optical instruments arose. It was our weakness in regard to the optical portion of the scientific instrument industry which was most conspicuously revealed by the war. In the first place, both France and Germany, even on a peace footing, had large standing armies, and the instruments of all kinds which were necessary for their equipment amounted to very considerable numbers. This gave an assured annual demand upon which the manufacturers could rely, and the home markets were moreover secured by tariffs on imported articles. The army requirements formed a sufficient basis upon which manufacturers could reasonably feel justified in putting down plant, or in making provision for production on a large scale. Mass production means cheap production. Manufacturing processes were so arranged as to divide the total operations into the most economical units and thus to ensure the maximum of repetition work. The methods adopted in France for production on a large scale were not the same as those which prevailed in the case of Germany. In both countries manufacture was subdivided into a large number of separate operations. In France, however, the separate parts were produced in the homes of the workers. They were collected and then assembled at some central factory. This method, apart from its known effects on labour costs, materially reduced the total cost of manufacture by largely eliminating overhead charges. From French industry was obtained the cheap instrument, such as the opera glass so familiar in our shop windows, attractive to the eye though of very doubtful optical quality. The large sales of these instruments depended essentially upon the lack of appreciation of optical performance on the part of the purchaser.

*Germany's Trade.*

Production in Germany, unlike that in France, was carried on by well recognised methods; the elements passing stage by stage through the various operations, arrived at a common centre for testing and assembling. Experience showed that the country which used these methods was the more serious competitor, inasmuch as it produced the type of high-class instrument which should have been manufactured in this country. We must now recognise the unpleasant fact that in the higher type of optical instrument we were outclassed. The British manufacturer did not feel justified in laying down the necessary plant for mass production; he was in many cases content to go forward on lines which had become antique. One may show how the system adopted in Germany affected the final operations in, say, the manufacture of a prism binocular. Under the German organisation, after the elements had been produced in a manner designed to ensure the greatest mathematical accuracy, the optical elements were further examined for the purpose of standardisation, and were classified according to their values. After being thoroughly cleaned they were sent forward to the assembling shop, where it was possible for the operator to select, by means of the data provided, the particular elements which he required, so that these parts were only handled once. By the system generally in vogue in this country the elements were not graded but were put directly into the bodies and an examination made; if the elements were not found satisfactory, they

were continually changed until a reasonable performance was obtained. This frequent handling of the parts wasted much time and led to very unsatisfactory results through the inclusion of dirt. This rule of thumb did not apply to all British manufacturers, nor does it represent present methods. But before the war it was common and explains why British quality failed as a rule to compare with German quality.

*High Reputation of German Instruments.*

The microscope industry furnishes a very instructive lesson of the manner in which the German instrument grew in repute. For several years before the war microscopes of continental manufacture practically held the field among certain classes of users, particularly in the medical profession and in many of the larger teaching institutions. It was in connection with microscope objectives that Abbé realised the impossibility of further progress unless certain types of glass, with characteristics differing from those which were then available, could be produced. With the production of these new glasses the optical performance of the German instruments made a great advance, and concurrently the mechanical parts and general design were improved. As a natural consequence German microscopy earned a well deserved reputation. Full advantage was taken of the position from a commercial point of view. Intensive cultivation of the British market was practised by representatives of the German manufacturers, who were careful to attend the meetings and conventions of the medical profession, and press forward their wares. They won over the demonstrators of the medical schools and also the professors of the universities and colleges. It may be noted that the German representatives were chosen for their technical knowledge, which enabled them to do this. The results were very far-reaching. Students became familiar during their training with the foreign instruments and remained attached to them in later years. The reputation of the foreign instrument then grew into a fetish, which lingers even now, though British instruments of satisfactory quality have become available.

*The War Changes.*

The advent of war brought about a revolution in the methods of production of scientific instruments in this country. The huge demands which arose had never before been known in the industry, and types of instruments had to be produced of which no previous experience existed. These types increased in number as the months went by, and the work of making the optical nstrument industry keep pace with the national necessi ies had to be done with restricted and more restricted nan power. Factories had to be extended and new ones uilt. Equipment was slow and progress was difficult, artly because the demand for machines was equally eavy in so many other essential fields of war pro- luction. Each arm of the Service was growing at an normous rate and equipment had to keep pace. The numeration of the various types of optical instru- ents required would constitute a formidable list, but hen it is recalled that some of them were wanted in ens of thousands, an appreciable estimate of the task et can be formed. There were rangefinders—from the mall infantry type of 80 cm. base to the giant of 100 eet base—other range finding instruments, such as the ekometer and telemeter, dial sights, directors, field lotters and range rules, telescopes and telescopic sights many and varied types for the different services, eriscopes—from the simple mirror type to the huge ructures of 30 feet for land and submarine uses—height nders, position finders for anti aircraft purposes, clino- eters, bomb dropping sights, photographic apparatus, xtants, compasses of many types, levels, theodolites, d other surveying instruments, and a countless array binoculars.

*The Requirements of Accuracy.*

It may not be realised how far production of optical instruments extend into the realm of mechanical engineering. Many of the instrument shops include a large engineering staff, who have to face and overcome no mean problems. Consider for one moment what would be the effect upon the value of an instrument and the utility of its fine adjustment—when accuracy has to be measured in seconds of arc—if there were a liability of flexure in its supports. We must not lose sight of the fact that not only was there the initial difficulty of producing the number of instruments required, but that these instruments had to pass the stringent standards set up by the various inspecting authorities. Satisfactory results were only accomplished by laying down the best available plant, planning the operations so as to take the fullest advantage of repetition work, by careful inspection at all stages and by precise assembling. The dial sight—an instrument vital to the artillery and one demanding extreme accuracy both mechanically and optically—furnishes an example of what can be accomplished. Before the war the demand for this instrument was not great, and supplies were obtained from abroad, but there was no surplus when war broke out. Supplies, therefore, had to be provided immediately and continuously. It is satisfactory to record that the demands were met, and the two British firms who undertook the task made and passed into service by the end of 1918 between 20,000 and 30,000 of these instruments. We received some assistance from neutrals and allies in obtaining certain stores, but as a set-off we sent instruments in large quantities to our Allies, particularly to Russia and America.

*The British Industry at Present.*

The close of the war found us with factories, plant, and personnel in excess of requirements if consumption were to fall back to our pre-war standard. The personnel had been trained in a highly specialised industry, and it would have been, from the national point of view, an economic waste if they had been lost to the trade. Moreover, in order to meet future calls on the industry it was essential to prevent disbandment as far as possible. The industry built up in war cannot be kept up in peace unless the scope of its markets is greatly enlarged. The demands of the peace Army and Navy will be small. It will therefore be necessary to look to commercial outlets to make up for the deficiency on military and naval work. Naturally attention is first directed towards those articles which before the war were imported in large quantities, and also to any industry which is likely to grow and to increase its calls for instruments. On the optical side, the spectacle industry, cinematographs, the microscope, and surveying instrument trades offer the greatest promise of successful demands. In other directions mathematical instruments, measuring instruments of precision, gauges, and wireless apparatus should afford employment to many who have been brought into the industry by the stress of war. Before the war 90 per cent of our spectacles came from abroad, and it was somewhat anomalous that British glass should have been sent to America to be returned to us as spectacles. New factories have arisen and are still springing up to manufacture spectacles, which it is hoped will supplant the imported goods, and before long British products should make an appreciable impression upon the market. Cinematographs were produced here before the war, but large numbers were also imported from France, Germany, and America. New firms have now entered into competition and aim at producing the highest types of instruments. Considerable progress has also been made in the other directions indicated, and if the assistance which is promised by the inclusion of scientific instruments as products of one of the "key" industries is granted, an era of prosperity for a war-created industry should be opened up. The lessons of the war cannot but fail to have had a material and

istry. But if advantage is not taken now to retain it we have won there is every possibility that the efits will be entirely lost.

*The Scientific Basis.*

'hat scientific instruments are absolutely vital to all services in war is, of course, acknowledged. But it y not be realised that we cannot remain in a position produce again in large quantities if we do not retain a iciently large number of highly skilled workers to wer the call. The employment in peace of the war sonnel will be possible if precautions are taken to foster industry. There should be a steadily growing demand instruments of various kinds in peaceful pursuits. entific methods and scientific training are advancing this country, but we are not yet in the position which rmany held before the war. Germany's remarkable vance in manufacture during the past thirty years has en largely due to the high scientific training of those the directing staff in her various industrial concerns, d probably in no other country was industrial science so ively fostered. Both industrial science and theoretical earch are essential to progress, and both call for the st accurate of scientific instruments. If encourage-nt be given in Great Britain to scientific methods in nufacture, then the means and apparatus to enable the rk to be carried on should be produced in this country. e creation of a large scientific instrument industry can-t be effected by waving of a wand. During the past e years the foundations have been laid, but it rests with e industry of the nation to build upon them a suitable ifice. We have at any rate abandoned the rules of umb and called science in aid. A research association s been formed to deal with the problems of manufac-re. Scientific investigations have and are being under-ken which promise to be of the greatest assistance in riving at the most satisfactory methods of production, d also in effecting material improvements in the instru-ents produced. All that the war-created industry needs time within which to establish itself securely.—*Board Trade Journal.*

# PROCEEDINGS OF SOCIETIES.

## PHYSICAL SOCIETY.

*Annual General Meeting, February 13, 1920.*

Prof. C. H. LEES, F.R.S., President, in the Chair.

'HE PRESIDENT delivered the Presidential Address, aking as his subject "*The Temperature of the Earth's nterior.*"

In an average cc. of matter within the earth's sub-tance the energy generated by radio-active matter is quivalent to the sum of the following quantities:—(1) Heat utilised in rise of temperature, (2) loss of heat by onduction, &c., (3) change in gravitational energy, (4) hermal stress.

The only factor known with certainty is the loss by con-uction which works out to an average of 10 ergs per nnum per cc. The approximate water equivalent of the naterial of the earth is 0·8, therefore a rise of temperature f 1° C. requires 33 million ergs. Hence, if there was othing to take into account but the conduction loss, the emperature would fall by 1° in 3·3 million years. The iscovery of radio-activity, however, showed that near the arth's surface the average amount of energy radio-ctively generated is 1000 ergs per cc. The quantity falls ff rapidly as deeper rocks are reached. The present Lord Rayleigh suggests that the average may be about 10 ergs —just sufficient to balance the heat lost from the surface. If we accept this theory we have to deal with a steady state, in which the temperature neither rises nor falls, and the calculation of the temperature at points inside the mass is simple. The equilibrium theory has been much criticised, however, and it is necessary to consider other alternatives. There are two possibilities:—Either the temperature may be rising, due to the radio energy exceeding the surface loss, or, it may be falling if the balance is the other way. The geological evidence renders the first contingency highly improbable. For a rate of change of temperature of 1° per million years the change in thermal energy involved is 33 ergs per annum per cc., while the change in gravitational energy is 20 ergs per annum per cc. These quantities can be lumped together and regarded as one by assuming the water equivalent of the earth's substance to be 1·6 times its actual value. Thus, neglecting radio-active effects, the time taken to cool 1° would be 5·4 million years instead of 3·3 million, as calculated without taking gravitational energy into account. From the relative amounts of lead and uranium found in rocks, it has been calculated that the time which must have elapsed since the formation of the crust is of the order of 1000 million years. The tempera-ture of solidification was probably about 1300° C., so we have the data necessary to give the present rate of cooling. From this, for any assumption regarding the actual distribution of radio-active material, the tempera-ture at points within the earth can be determined.

Principal S. SKINNER moved a vote of thanks to the President for his Address, and asked him in the name of the Society to allow it to be published in the *Proceedings.*

A paper on "*The Influence of Small Changes of Tem-perature on Atmospheric Refraction*" was read by Sir ARTHUR SCHUSTER.

The paper is an investigation of the possible deviation of the light from a star near the sun due to the tempera-ture changes in the atmosphere produced by the passage of the moon's shadow across the earth during an eclipse. It is shown that while the actual displacements from this cause vary widely for slight differences in the assumed conditions, they are always negligibly small compared with the effects observed at the last solar eclipse.

DISCUSSION.

Mr. T. SMITH said he had not grasped the necessity of assuming that the phenomena would be symmetrical about the centre of the sun. If this limitation were dis-pensed with in the treatment, much larger displacements might be obtained.

Prof. SCHUSTER said the symmetry was necessary to account for the actual observations.

Dr. CHREE said he was not convinced that the actual observations justified the assumption of symmetry. Of the fifteen or so stars on the plate, probably only five or six were of significance, and he did not think that they gave unquestionable evidence of symmetry in the displace-ments. Moreover, during any single eclipse, the time of day is changing, and it is impossible to get the unmixed temperature effects of the eclipse alone. A large number of eclipse observations would have to be made and com-pared before the evidence was regarded as conclusive. Further, he thought such observations should be made from a considerable height, as observations taken near the surface of the earth were always subject to variable local disturbances.

Mr. F. J. W. WHIPPLE said he did not see the justifica-tion for assuming that the pressure could be regarded as uniform. Convection could hardly equalise the pressure in the time available. It might, in fact, increase the dif-ference. The shadow traversed the earth at a very high speed, and a pressure wave might be sent out. Tempera-ture effects might also arise from the passage of this adiabatic disturbance through the atmosphere.

Prof. SCHUSTER agreed that the assumption of equality of pressure presented a difficulty; but he thought convec-tion would undoubtedly reduce any differences rather than increase them.

*General Business.*

It was moved by the PRESIDENT and seconded by Dr. BORNS that the Reports of the Secretary and Treasurer be adopted.

This was unanimously carried.

On behalf of the Council, the PRESIDENT moved:— "That this General Meeting of the Physical Society of London approves of the foundation of an International Union of Physics."

This was seconded by Mr. GUILD and carried unanimously.

The scrutineers, Prof. G. W. O. HOWE and Dr. BORNS, reported that the new Council, as proposed on the balloting list, had been elected:—

*President*—Prof. W. H. Bragg, C.B.E., M.A., F.R.S.

*Vice-Presidents (who have filled the office of President)*—Prof. R. B. Clifton, M.A., F.R.S.; Prof. A. W. Reinold, C.B., M.A., F.R.S.; Sir W. de W. Abney, R.E., K.C.B., D.C.L., F.R.S.; Sir Oliver J. Lodge, D.Sc., F.R.S.; Sir Richard Glazebrook, K.C.B., D.Sc., F.R.S.; Prof. J. Perry, D.Sc., F.R.S.; C. Chree, Sc.D., LL.D., F.R.S.; Prof. H. L. Callendar, M.A., LL.D., F.R.S.; Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.; Sir J. J. Thomson, O.M., D.Sc., F.R.S.; Prof. C. Vernon Boys, F.R.S.; Prof. C. H. Lees, D.Sc., F.R.S.

*Vice-Presidents*—H. S. Allen, M.A., D.Sc.; Prof. W. Eccles, D.Sc.; Prof. A. S. Eddington, M.A., M.Sc., F.R.S.; R. S. Willows, M.A., D.Sc.

*Secretaries*—D. Owen, B.A., D.Sc. (Birkbeck College, Bream's Buildings, London, E.C.4); F. E. Smith, O.B.E., F.R.S. (National Physical Laboratory, Teddington).

*Foreign Secretary*—Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.

*Treasurer*—W. R. Cooper, M.A., B.Sc. (82, Victoria Street, S.W. 1).

*Librarian*—O. Rankine, D.Sc. (Imperial College of Science and Technology).

*Other Members of Council*—C. R. Darling, F.I.C.; Prof. C. L. Fortescue, O.B.E.; E. Griffiths, D.Sc.; E. H. Rayner, M.A., D.Sc.; A. Russell, M.A., D.Sc.; Prof. Sir Ernest Rutherford, D.Sc., F.R.S.; G. F. C. Searle, M.A., D.Sc., F.R.S.; T. Smith, B.A.; J. H. Vincent, D.Sc., M.A.; F. J. W. Whipple, M.A.

A vote of thanks to the Honorary Auditors was moved by Dr. C. CHREE and seconded by Dr. A. GRIFFITHS.

A vote of thanks to the Retiring Officers and Council was moved by Prof. BRAGG and seconded by Mr. C. C. PATERSON.

A vote of thanks to the Governing Body of the Imperial College was moved by Prof. HOWE and seconded by Dr. RAYNER.

## SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

*Ordinary Meeting, March 3, 1920.*

Mr. ALFRED SMETHAM, President, in the Chair.

CERTIFICATES were read for the first time in favour of Messrs. Laurence Harry Mills, B.Sc. (Birmingham) A.I.C., and Frederick Robertson Dodd, F.I.C.

Certificates were read for the second time in favour of Messrs. Henry Atlas; John Carmichael, F.I.C.; Herbert John Evans, B.Sc., F.I.C.; Cornelius Durham Garbutt; Douglas Henville, F.I.C.; Maurice S. Hutchinson, B.Sc.; Benjamin Richards James, F.I.C.; Geoffrey Martin, D.Sc., Ph.D., F.I.C.; Robert Leitch Morris, F.I.C.; James Wood, M.A., B.Sc., F.I.C.

The following was elected a Member of the Society:— Mr. William John Read, M.Sc., F.I.C.

Papers, of which the following are abstracts, were read:

"*The Detection of Finger-prints on Documents.*" By C. AINSWORTH MITCHELL, M.A., F.I.C.

[illegible] illustrating with specimens fifty-six years old. He discusses various methods of detecting finger-prints on documents, by means of mechanical methods, dyes, chemical reagents, iodine vapour, &c. He then goes to discuss the persistence of stains on paper, including blood finger prints, and closes with a full bibliography of the subject.

"*Photo-micrography with Simple Apparatus.*" By T. J. WARD.

The author gives some simple methods for the production of low-power photo-micrographs, together with demonstration of his apparatus for magnifications not exceeding ×40, and descriptions of methods of illumination employed.

Lantern-slides were exhibited illustrating results obtained.

"*Note on the Solubilities of Theobromine.*" By R. WADSWORTH.

The solubility of theobromine in most of the common solvents has been redetermined by the author. The figures obtained are compared with those given by a number of authorities, the difference being found to be very great in some cases.

## CORRESPONDENCE.

### SCIENTIFIC AND TECHNICAL BOOKS.

*To the Editor of the Chemical News.*

SIR,—One part of the Descriptive Catalogue of the British Scientific Products Exhibition, organised by the British Science Guild last year, was devoted to selected lists of books on Science and Technology.

The Guild has been asked to extend these lists, so as to include not only all branches of science—both Biological and Physical—but also the chief technical subjects. [It] has undertaken to do this; and a Committee, of which [I] am Chairman, has been appointed to prepare such a catalogue.

The lists will be limited to books of British origin actually in current catalogues of the publishers, so that they can be obtained in the usual way through booksellers. School-books and elementary manuals will not be included, and the general standard will be that of college courses in scientific and technical subjects, or of works for libraries. Each list will be submitted to authorities upon the subject with which it deals, but in order to secure that no important work is omitted, the Committee invites the assistance of everyone interested in its task. Such help may be afforded by sending (to the British Science Guild, 6, John Street, Adelphi, London, W.C. 2) lists or single titles of British books of standard value or proved worth in any branch of science and industry. I shall much appreciate help of this kind which any of your readers may be able to give.—I am, &c.,

R. A. GREGORY.

## NOTES.

MERCURY.—His Majesty's Commercial Counsellor at Rome quotes *Il Solo* as stating that combinations are being considered to concentrate the whole European production of mercury in the Monte Amiata Company. The recent considerable realisation of the Company's shares, which caused a fall in their price, was the selling by German holders owing to the advantage derived from the exchange. Excellent results are expected from the work [illegible]

that, with the acquisition of the mines in Istria, Italy the main sources of mercury in Europe in her ssion.

IE ROYAL SOCIETY.—The Council of the Royal ety decided on February 26 to recommend for election the Fellowship of the Society the following fifteen the list of candidates:—Dr. Edward Frankland strong, Sir Jagadis Chunder Bose, Dr. Robert Broom, Edward Provan Cathcart, Mr. Alfred Chaston man, Dr. Arthur Price Chattock, Mr. Arthur William Dr. Cargill Gilston Knott, Prof. Frederick Alexander emann, Dr. Francis Hugh Adam Marshall, Dr. nas Ralph Merton, Dr. Robert Cyril Layton Perkins, Henry Crozier Plummer, Prof. Robert Robinson, Prof. John William Watson Stephens.

OYAL INSTITUTION.—A General Meeting of the mbers of the Royal Institution was held on March 1, ames Crichton-Browne, Treasurer and Vice-President, e chair. The Chairman reported the death of Dr. rson Reynolds, a late Manager of the Institution, and olution of condolence with the relatives was passed. special thanks of the members were returned to Mr. ey G. Brown for a donation of £12 to the general s of the Institution. Prof. W. H. H. Bragg, Mr. W. er, Mrs. Stanton Coit, Major-Gen. T. M. Corker, Mr. . Crowley, Sir Charles Cust, Mr. C. F. de Canabl, K. Grey, Miss Kershaw, Miss Kinnear, Miss McGhee, .-Gen. E. Makins, Capt. H. G Mason, Dr. C. G. rell, Lady Rayleigh, Mr. W. B. Saville, Mr. K. G. R ey, Miss Wagner, Prof. F. Womack, and Lieut.-Col. Wright were elected members.

OVERNMENT MANUFACTURE OF DRUGS IN INDIA.—An ial communiqué announces that a Drugs Manufacture mittee was appointed last year to investigate the ibilities of the cultivation of medicinal plants in India the manufacture of drugs on a commercial scale. intention of the Government is that as soon as exence proves that any drug can be manufactured at the ernment medical store depots at a sufficiently low cost ate enterprise should be invited to undertake the manuure. The communiqué states that considerable pros has already been made, and enumerates over fifty arations which were imported before the war, but ch are now manufactured at the medical store depots. list includes preparations of alcohol, aloes, silver ites, belladonna, calcium, citric acid, collodium, ara, digitalis, glycerin, nux vomica, iron, French k, glucose, iodine, lysol, potassium, soft soap, sodium, ferro-phosphates, thymol, and mercury.—*Reuter's le Service.*

ESUMPTION OF ACTIVITY IN GERMAN CHEMICAL INTRY.—The chemical industry, which for several ths has been practically at a standstill, has resumed ations on a full scale, a sufficient supply of coal ng been received from the Ruhr region. The 100 on loads of American coal, for which an agreement recently concluded, has not yet been received.—*ter's Trade Service.*

ROSPECTS OF CEREAL SUPPLIES IN 1920.—The most worthy information included in the February Statis Bulletin, just published by the International Institute griculture (Rome), is that dealing with the dislocation e rates of exchange applicable to the grain trade. consequence of this dislocation the principal importcountries have to submit to an increase in cost at port hipment varying from 12 per cent to 25 per cent rding to the country of destination of the grain, and ompared with the amounts payable in December last. s enhancement naturally acts as a barrier to new ness. It is announced that the United States, with rger crop of wheat in process of distribution, had ped nearly one million tons less during the last six ths of 1919 than in the corresponding period of 1918, that wheat stocks in the hands of farmers, millers, and dealers in that country were in January 1920 larger by 3¾ million metric tons than in January 1919. It is estimated that the stocks of rye in the United States were also greater by 400,000 tons than they were last season. The cereal harvests of the Southern hemisphere are now practically complete. To the data published under this heading in the Bulletin of January, is now added the yield of barley in Argentina, amounting to 240,000 tons, much beyond (202 per cent) the five years' average 1913-1914 to 1917-18. The increase is partly due to the area being 37 per cent over the average, but is chiefly the result of the propitious season, which has doubtless had its influence upon the wheat crop, though that yield is not yet officially announced. No information as to the actual yield in Chile is yet to hand, but it is reported that the wheat crop was in excellent condition at harvest time, and other cereals promised well. As regards winter sowings in the Northern hemisphere it is an ascertained fact that the area under wheat in the United States is much reduced (the area now under crop is 77 per cent of last year's). Decreases in area sown are also reported from Spain, Roumania, and Egypt, while more extensive cultivation has taken place in France and Algeria, and is most noticeable in British India (with 15 per cent more than last year). The crop conditions are reported as fairly favourable in Belgium, Great Britain, Ireland, Spain, and Italy, average in Egypt, while drought has been detrimental in Algeria. The approaching harvest in British India is expected to be a good one.

## MEETINGS FOR THE WEEK.

*Monday, March 15.*

Royal Geographical Society, 8.30.

*Tuesday, March 16.*

Royal Institution, 3. "British Ethnology," by Prof. Arthur Keith.

Institution of Petroleum Technologists, 8.30. "Plant used in the Rotary System of Drilling Oil Wells," by Maurice A. Ockenden and Ashley Carter.

Mineralogical Society, 5.30.

*Wednesday, March 17.*

Institution of Electrical Engineers, 5.30. "Duplex Wireless Telephony," by Capt. P. P. Eckersley.

Royal Society of Arts, 4.30. "Street Passenger Transport of London," by W. Worby Beaumont.

*Thursday, March 18.*

Royal Society, 4.30. "A Form of Botrytis Cinerea with Colourless Sclerotia," by W. B. Brierley. "Preliminary Account of the Meiotic Phenomena in the Pollen Mother Cells and Tapetum of Lettuce (Lactuca Sativa)," by R. R. Gates.

Royal Institution, 3. "Spirit of America after the War," by Stephen Graham.

Institution of Electrical Engineers, 5.30.

Chemical Society, 8. "Viscosity of Nitrocellulose n Mixtures of Acetone and Water," by I. Masson and R. McCall. "Introduction of the Chlorometthy Group into the Aromatic Nucleus," by H. Stephen, W. F. Short, and G. Gladding. "Influence of the Solvent on the Velocity of Reaction between certain Alkyl Iodides and Sodium β-naphthoxide," by H. E Cox. "Use of 1 : 2 Dichlorovinylethyl Ether for the Production of Chloracetates and Acid Chlorides," by H. Crompton and P. L. Vanderstichele.

*Friday, March 19.*

Royal Institution, 9. "Leonardo da Vinci," by Edward McCurdy.

Royal Society of Arts, 4.30. "The Indian Currency System and its Developments," by Sir William S. Meyer.

*Saturday, March 20.*

Royal Institution, 3. "Positive Rays," by Sir J. J. Thomson.

**Chief Chemist wanted, with expert knowledge** of Hæmatite and Basic Iron, Acid and Basic Open-hearth Steel, Fuel, Coke-oven By-product work, &c.—Apply, stating age, salary required, and experience, to the Secretary, Consett Iron Company, Ltd., Consett, co. Durham.

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**Ex-Soldier (20), single, Matriculated, three** years' experience in Analysis of Foods, Drugs, Oils Fats, Soaps, Metals, and Coal, desires Position as Assistant Analyst or Works Chemist.—Address, X. S., CHEMICAL NEWS Office, 16, Newcastle Street, Farringdon Street, London. E.C. 4.

**EVENING CHEMICAL WORK—Labora**tory, Clerical, or Teaching—wanted by Lady with B.Sc. training and works experience. Accustomed to library "digging."—Address, E. W., CHEMICAL NEWS Office, 16, Newcastle Street, Farringdon Street, London, E.C. 4.

**Lady, B.Sc., seeks Post in Analytical Labora**tory.—Address, H. J., CHEMICAL NEWS Office. 16, Newcastle Street, Farringdon Street, London, E C. 4.

**Young Lad seeks Position in Analytical Lab**oratory. Good experience.—Address, Y. L., CHEMICAL NEWS Office, 16, Newcastle Street, Farringdon Street, London, E. C. 4

**Young ex-Service Man (21), Matric distinc**tion Chemistry, Mathematics, desires opening in Analytical or Testing Department of Manufacturing Chemist (Pharmaceutical or Photographic) while training for Technical Examinations.—Address Hammersley, 125, Napier Road, Tottenham, London, N. 15.

**Wanted, a young Physicist to take charge of** Department making Steam and other Pressure Gauges. State salary and experience.—Address, Cliffe, Great Brook Street, Birmingham.

**LABORATORY BENCH for Sale, 5 ft.** by 3 ft. 6 ins. by 3 ft 3 ins.; solid Teak top; fitted with Cupboards, Drawers, and Gas Fittings. £25.—Apply, 1, Liberia Road, Highbury, N. 5.

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**The Owners of BRITISH PATENT No.** 105906, relating to

"A PROCESS FOR OXIDISING AMMONIUM SULPHITE TO AMMONIUM SULPHATE,"

are desirous of entering into negotiations with one or more firms in Great Britain for the purpose of exploiting the above invention, either by Sale of the Patent Rights or by Granting Licences to Manufacture under royalty.

Enquiries should be addressed to—

MESSRS ABEL and IMRAY, Chartered Patent Agents, 30, SOUTHAMPTON BUILDINGS, LONDON, W.C. 2.

**If in good condition, Sixpence per copy will be** paid for any of the undermentioned numbers of the CHEMICAL NEWS which may be forwarded to this office:—

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3062, December 6th, 1918.
3063, December 20th, 1918.
3064, January 3rd, 1919.
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3068, January 31st, 1919.
3069, February 7th, 1919.
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The goods may be inspected on presentation of th form of tender to the Deputy Director of Clothin Royal Army Clothing Department, Grosvenor Roa Pimlico, S.W.1.

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EXETER.—Labour Exchange, Queen Street.
GLASGOW.—Pattern Room, Ministry of Munitions, 250, S Vincent Street.
LEEDS.—Chamber of Commerce, 26, Park Row.
LEICESTER.—Chamber of Commerce, 3, Granby Street.
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AGRICULTURAL COLLEGE

E CHEMICAL NEWS

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## E WATER OF FORT DODGE, IOWA.

By NICHOLAS KNIGHT and WILBUR HOFF.

)ODGE, Iowa, is supplied by a system of seven wells edge of the city and by others farther away. seven are located near the Des Moines river and a ributary stream.

e are extensive deposits of gypsum in and around odge which affect the quality of the water. These s belong to the Mississippian, including the sub-iferous and carboniferous. We made an analysis of .er of three of the wells, believing them to be repre-ve of the entire series.

1, 1827 feet deep. It terminates in the Jordan me of the Cambrian. The water used in the s probably came from a depth of 1431 feet, from nt Peter Rock above the Ordovician.

| | Parts per million. |
|---|---|
| Total solids | 846 0 |
| Silica | 6 0 |
| Ferric oxide | 3·0 |
| Calcium sulphate | 455·9 |
| Magnesium carbonate | 167 9 |
| Sodium and potassium chloride | 198 9 |
| Total nitrogen | 0 1 |

No. 2. Depth 670 feet.

| | |
|---|---|
| Total solids | 618 6 |
| Silica | 8·0 |
| Ferric oxide | 14·0 |
| Calcium carbonate | 165·2 |
| Calcium sulphate | 235·3 |
| Magnesium carbonate | 160·8 |
| Sodium and potassium chloride | 23·1 |
| Nitrogen | 0·05 |

215 feet deep terminating in t e Mississippian.

| | |
|---|---|
| Total solids | 565·6 |
| Silica | 7 6 |
| Iron oxide | 8 6 |
| Calcium carbonate | 81·9 |
| Calcium sulphate | 270·8 |
| Magnesium carbonate | 140·7 |
| Sodium and potassium chloride | 23·1 |
| Nitrogen | 0·1 |

No. 4. The River Water.

| | |
|---|---|
| Total solids | 530 6 |
| Silica | 14·6 |
| Ferric oxide | 0·6 |
| Calcium sulphate | 316·2 |
| Calcium carbonate | 3·4 |
| Magnesium carbonate | 235·4 |
| Sodium and potassium chloride | 23·1 |
| Nitrogen | 2·2 |

ast analysis shows that a river water is not neces-oft, but may be quite hard as in the present . The water of this stream may vary considerably ess in different seasons of the year, as it is fed by water from numerous springs, and this water dis-otable amounts of calcium carbonate and sulphate ich it comes in contact. In times of flood the content may appreciably decrease.

would seem to be no advantage in deep wells somewhat shallow wells that partly supply the

College, Mount Vernon, Iowa.

## THE DEVELOPMENT OF A GRAPHITE INDUSTRY,

AS ILLUSTRATED BY THE HISTORY OF THE QUEBEC GRAPHITE CO., LTD.*

### *Brief History of Graphite.*

THE mineral now known as graphite has been in commercial use for many years. Its true chemical nature consists only of the element carbon, and was first recognised as such by Scheele, 1742-88. Previous to this it was generally supposed to be "dead," and in those early days, on account of its distinctive marking on paper and porcelain, was shaped into crayons, and was called "lead pencil," hence this erroneous appellation for the article, which has still remained. The first discovery of its purest form was at Borrowdale in Cumberland, England.

### *Description of Properties.*

Graphite, or "Plumbago," has a greyish black colour with a metallic lustre, soft and soapy to the touch. It is a perfect conductor of heat and electricity, and is impervious to all acids or alkalies.

It also has an extremely low resistance to friction, and on account of its softness will find its way into the minutest pores in a bearing, making it run smooth and sweet. It occurs in the crystalline and amorphous forms. *The former has several different forms of occurrence,* hexagonal prisms, needle-shaped crystals, in foliated masses (often called "chip plumbago"), or flakes disseminated throughout the rocks of its occurrence. The amorphous variety more resembles a graphite shale, and approaches the true coal series. Thus there are three distinct allotropic forms of pure carbon—diamond, graphite, and coal. The method of occurrence and physical properties of each are entirely different; where one is detrimental to lubrication, as in "carbonised" cylinders and bearings—graphite is used to eliminate it and cause smooth running.

### *Geology.*

The ores of the Buckingham district are chiefly of the flake variety. The country rock is a crystalline limestone of the Grenville series, interbanded by a complex of pyroxine gneisses, gabbro, pyroxine diorite, proxine syenite and pegmatites composing the Buckingham series.

The whole mass is intensely deformed and twisted, and there is a great enrichment of graphite at the contacts of the pegmatite intrusions, the ore occurring in distorted lenticular masses, flakes of graphite can be traced far into the limestone on either side of the ore bodies. These ore bodies average from 12 per cent to 16 per cent carbon.

Graphite was mined from the Buckingham district as far back as 1845, and from then to the present date an enormous amount of money has been spent, much thought and originality has been shown, in trying to solve the problem of graphite concentration in this district. Some *extraordinary difficult features are presented, chiefly be*cause the specific gravity of graphite, which is 2·25, is only slightly less than that of its accompanying gangue, which is from 2·5—2·7, and the natural shape also tends to aggravate the problem. Dry methods of concentration, with their accompanying inconveniences from dust losses and difficulties of operation, were always carried on. While all due acknowledgment is to be made to the pioneers of the industry, it must be granted that the commencement of operations by the Quebec Graphite Co., Ltd., who used wet concentration, marks one of the first milestones of progress in this direction.

### *History of Quebec Graphite Co., Ltd.*

The present mines and mills of the Quebec Graphite Co., Ltd., are situated about four miles east of Buckingham,

* Published with the permission of V. Eardley-Wilmot, General Manager, Quebec Graphite Co., Buckingham, Quebec.—*Canadian*

P.Q., on lots 1-4. This property was taken over by the British Company from the Natal Company, who obtained it from H. E. Dixon, of Ottawa. During 1910 and 1911 a parcel of graphite ore was sent from lot 3 to the works of Fried Krupp, Magdeburg, Germany, and after a long series of experiments, what was supposed to be a satisfactory process of concentration was evolved. This process was on the wet gravity lines, its outstanding features being very careful classification and a unique finishing plant.

The Quebec Graphite Co. was thus formed in London to work the contemplated process. Its capital was £100,000, and building and mining operations were begun in 1912. Owing to climatic conditions, non-arrival of parts, and scarcity of labour, installation of the plant, which was entirely under German jurisdiction, was not completed till September, 1913. The machinery was all German, and consisted of initial crushing and grinding units, sixteen gravity tables, classifiers, dewaterers, dryer and finishing plant. Power was supplied by a 160 h.p. Diesel oil engine.

It was expected that the rough concentrate would run about 80 per cent carbon, which would then be brought up to 90 per cent carbon by the finishing plant. No time and money had been spared in the installation, and on September 26, 1913, milling operations were begun. At an early date defects in the initial crushing and grinding installation were noted. A rough 80 per cent concentrate could not be produced, and the recovery also was unsatisfactorily low; furthermore, the plant was designed in a country where labour was cheap, and consequently the enormous amount of man-handling and disregard for labour-saving devices in this mill tended to make milling costs very high. Also the drying apparatus was hopelessly inefficient. Thus the contract of the German firm was not fulfilled, and the German engineers left the scene of operations before the accomplishment of their task, and with the usual "promises" of better improvements. Had the company known that nation as they do to-day, they would have at once severed all connections with them. However, further experiments were initiated at Krupp Works with the object of overcoming these defects, and it was again "supposed" that a satisfactory solution had been found. Meanwhile the plant had run through the winter, but was finally closed down for readjustments on June 17, 1914.

Work of dismantling proceeded, some of the new machinery was sent from Germany, arrived, and was installed, but some was not shipped at the outbreak of the war in August, 1914. At this period the company's finances, due to the investigations and alterations, were becoming strained. British Treasury regulations and a moratorium in England, made it difficult to raise further funds, and all work was finally stopped early in September, 1914, and the company went into voluntary liquidation early in 1915, and was reconstructed under the name of The New Quebec Graphite Co., Ltd.

The new company restarted operations on July 19, 1915, and the work of remodelling the plant was resumed. The old plant, with the missing units still in Germany, was repaired and tuned up as well as possible, and a test was run in the end of September, 1915. This was fairly satisfactory, but the management considered the mining outlook very unpromising, as at that date no deposits of value were developed, and practically no ore was in sight.

The works were therefore closed down again until April, 1916; all German superintendents and interests were displaced, and Mr. R. C. Rowe and Mr. C. N. Daly, who had considerable experience in mining and milling graphite in this district, were appointed as works managers, and operations were again resumed. It was felt that defects in recovery would be in some measure offset by the increased price of graphite, and it was the company's policy to return any profits into development of the property and investigations for improving the milling process. For a period of two years under this new management the plant ran steadily and productively. A scheme of prospecting was followed, and new an promising deposits were uncovered and develo indications of almost unlimited quantities of c shown to exist. During this period investigati increasing the efficiency of the plant were also co.

The impossibility of obtaining spare parts German machinery was a heavy strain. Eve therefore, no matter how small, had to be drawn, made and specially cast, deliveries were bad and ir and consequently the efficiency of the plant s Moreover the old inherent defects were still pre spite of the German "promises," and this, coupl the ever-increasing cost of supplies and labour, cessation of operations in April, 1918. After th the company turned its attention very seriously to i ing the recovery of values in the concentration Investigations in flotation concentration of several d processes were conducted in Canada, U.S.A., England. But the strain of these continued inv tions was, however, too great, and the company went into voluntary liquidation.

In June, 1919, the British Company again deci start afresh, with drastic alterations and new ideas this new company was called The Quebec Gr Co., Ltd.; head office at 4, Fenchurch Avenue, Lo England. Mr. V. L. Eardley-Wilmot, recently re from the army, a mining engineer from British Colu was appointed general manager, who, after prelim investigations in England, came over to reorganis start operations on a new scale. After careful stu the latest methods of ore concentration both in E and Western Canada, and exhaustive tests and e ments, the present and latest method of graphite co tration was decided on, both in consideration efficiency and for the reasonable cost of plant engineer fees.

The results of these experiments with this new pr have proved that the very highest grades of both c and fine flake graphite can be produced from the pany's property at Buckingham. The company is much indebted to the invaluable assistance given to t by the Mines Branch at Ottawa.

Remodelling of the mill on these new lines st during August, 1919, directly under the supervisio R. C. Rowe. The old Krupp process has been defin discarded. The initial crushing and grinding plant been entirely reconstructed with the latest mills. dewatering and drying equipment has been altered, additions have been made to the already highly effic finishing plant, and it is hoped that the company will able to sell some of its discarded units.

The economic geology of the property in the vicinit the mill has been investigated, and further explora has revealed a large ore body of the highest grade has been milled in recent years. The company's prop is very extensive, and is permeated throughout with best Canadian flake, and several years' supply of ore be obtained from the small portion prospected, whil close study of the geology shows that at least seven-ten of the property, which has barely been walked over, m contain an almost inexhaustible supply, and there therefore not the slightest doubt that the company now reap the benefit of their long continued and p sistent enterprise.

*Commercial Products.*

From some of the extremely high-grade coarse and fi graphite produced all manner of commercial products being manufactured. These to be immediately put on t market are:

1. A high-grade coarse crucible flake, 90 per ce carbon, and mica free.
2. Several high grades of powdered lubricants, in cas for all kinds of machinery and automobiles.
3. Fine flake graphite.

Foundry facings for all purposes.
Graphite dust.

complete line of graphite products is also now being rimented on, amongst which may be listed graphite ses of all grades, stove polishes, graphite paints, pipe boiler compounds. Experiments in the manufacture of rodes and electric materials are under consideration.

ie company expects to establish at least one factory anada and one in England for manufacturing these ucts.

ie management has the advantage over other graphite erties, in that it possesses what is the crux of the tion, in the form of the very highest grade finishing lishing rolls, and these, in combination with the last in graphite concentration, enables them to be able onomically produce all the above products at a conably reduced price on the present imported goods. company is also fortunate in having a very sound icial backing in their British directors, who are among best-known business men in London, England.

ie idea has been prevalent that Canadian flake is not ood as Ceylon, but this has chiefly been in the past a tion of purity, and by recent methods of concentraand finishing it has been shown that the Canadian in its pure state can hold its own, for any purpose, nst all outside grades of this mineral. The managers ll thoroughly experienced in graphite and its concenon, and being alive to their opportunities, the new stry should branch out into almost any proportions. market will not be confined only to this continent, negotiations are already under way for disposal of ucts throughout Europe and the Far East.

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## E USE OF HALOID CYANIDES FOR THE PURPOSE OF GOLD EXTRACTION.*

By T. B. STEVENS and C. E. BLACKETT.

(Concluded from p. 23).

*ree of Alkalinity*.—A further precaution exists in g cyanogen bromide in that no appreciable amount of ective-alkali must be present. This is quite contrary he usual practice with plain cyanide in the use of ch it is customary to keep a good margin of safety as rds protective-alkali. All of the cyanogen haloids very rapidly decomposed by caustic alkalis, and again nis instance the products of the decomposition are not ents of gold.

$$CNBr + 2NaOH = NaBr + NaCNO + H_2O.$$

n an experiment to show the rate of destruction a solu was taken containing 0·198 per cent KCN and 0·05 cent CNBr and divided into two portions. To one of e lime was added equivalent to 2 lbs. per ton of solu (0·1 per cent CaO), and to the other none was added. y were allowed to stand for thirty minutes, and their ective strengths were then estimated. The one withlime contained 0·188 per cent KCN and 0·034 per cent Br, whereas the one containing the lime contained 92 per cent KCN and no CNBr. The lime destroyed tically all the cyanogen bromide, and by so doing ented the potassium cyanide from being decomposed it.

further experiment may be given to show the effect ch the addition of alkali has on the extraction of gold n used with cyanogen bromide as compared with plain nide. A sample of sulpho-telluride ore was taken and shed to pass through a 60-mesh sieve; it was then ced in a small tube-mill with an equal rate of water ground until all the pulp could pass through a 150-mesh screen. Two pounds of commercial lime per ton were added before grinding. When removed from the mill the pulp was just alkaline, and it was divided into four similar portions, which were placed in bottles. One of these was treated by plain cyanide solution, and the other three were treated with the cyanogen bromide solvent with the addition of varying amounts of lime. The results were as follows:—

*The Effect of Protective-alkali on Cyanogen Bromide Treatment.*

Original value of the ore was 44·8*s*.
Time of agitation, 12 hours.

| No | KCN per cent at start. | CNBr per cent at start. | CaO lb per ton. | KCN per cent after agitation. | Protective alkali after agitation. Per cent CaO. | Residue shils | Extraction per ton. |
|---|---|---|---|---|---|---|---|
| 1. | 0·2 | Nil. | 4 | 0·095 | 0·009 | 10 3 | 77 33 |
| 2. | 0·2 | 0 05 | 6 | 0·101 | 0·003 | 10 1 | 77 45 |
| 3. | 0·2 | 0 05 | 4 | 0·102 | Nil. | 6 7 | 85 40 |
| 4. | 0 2 | 0·05 | 2 | 0 062 | Nil. | 5 6 | 87 50 |

These results show that when sufficient lime is added, to produce protective-alkali, cyanogen bromide does not give any better extraction in the same time than does the plain cyanide, and by far the best extraction is obtained by cyanogen bromide when the lime is reduced to a minimum. In practical work it is necessary to regulate the addition of lime in order that sufficient is present to neutralise the acidity of the ore, yet at the same time an excess which would decompose the cyanogen bromide must be avoided. It will be recognised that a very much closer control of alkalinity is required than when the plain cyanide process is used. Our own experience shows that as long as the solutions contained in the agitators do not show a protective alkalinity in excess of 0·002 per cent CaO as determined by Clennell's method, the dissolving of the gold is not interfered with to any serious extent, and no excessive consumption of alkaline cyanide will take place. By using a higher alkalinity cyanide is saved, but the residue value is increased, and, by keeping the solutions acid, the highest extraction is obtained but the consumption of cyanide is necessarily increased. The metallurgist in charge has therefore to arrange conditions which will give no excessive loss of either gold or cyanide with the particular ore which he is treating.

All the plants using this process with which we are familiar have been arranged to crush the ore in cyanide solution, and it is customary to add lime with the ore in the battery boxes to such an amount as to maintain the solution in which the ore is crushed and concentrated very slightly alkaline. By so doing the pulp entering the agitators can usually be relied upon to be neutral or slightly acid. In the latter case sufficient crushed lime can be added to make it neutral or just faintly alkaline. It will be seen that we have a very ready means at our disposal of adding alkali to charges during agitation; but in the event of charges being too alkaline we have no means of obtaining acidity beyond that developed by the latent acidity of the ore.

After the pulp has been agitated, the treatment of it as regards alkalinity varies at different plants. At one time it was considered essential before filtering a slime pulp to make it strongly alkaline by the addition of lime in order to increase the cyanide strength by decomposing the double zinc cyanide, and at the same time destroy any cyanogen bromide which remained. These precautions were considered necessary to obtain successful results in the subsequent operation of precipitating the gold from the solution in the extractor boxes. This custom has to a great extrent prevailed, but the idea of destroying the remaining cyanogen bromide is erroneous, as none has

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* Read before the Institution of Mining and Metallurgy, February 1920. From the *Bulletin of the Institution of Mining and Metallurgy*, February, 1920.

ever been found to exist in an agitation vat three hours after it has been added.

It has been shown at one plant that it is unnecessary to make solutions alkaline before they are delivered to the precipitation boxes, as the work done in these extractors suffers in no way by omitting this step, whilst the consumption of zinc shavings is very much reduced. The degree of alkalinity for precipitation is of little consequence, but if magnesium salts are present in solution any sudden variation must be avoided. If no lime is added to the solutions before precipitation, it is perhaps unnecessary to mention that greater quantities must be added in the battery boxes in order to maintain the neutrality of the plant circulating solution.

When the process was first introduced at Kalgoorlie the adjustment of the alkalinity was a comparatively simple matter, as salt water was in use in the plants, and owing to the large amount of magnesium salts which this water contained, it was not possible to get any appreciable degree of protective alkalinity without the addition of such enormous quantities of lime as to make the use of it impracticable. But with this water a low alkalinity, equivalent to 0·002 per cent CaO, could be readily obtained owing to the slight solubility of magnesium hydroxide. This was an ideal condition, and was self adjusting, as if any excess of lime was added it was consumed in precipitating magnesium hydroxide, and did not combine with the cyanogen bromide. To show this experimentally we prepared a solution containing 1 per cent $MgSO_4$, 0·2 per cent KCN, and 0·05 per cent CNBr, and lime at the rate of 2 lbs. per ton of solution. Another solution was prepared with the same amount of lime but omitting the magnesium sulphate. Both solutions were then tested for cyanogen bromide at intervals of a few minutes. In the one containing the magnesium salt 0·02 per cent of CNBr remained after three hours, but in the other solution all the CNBr had been destroyed in fifteen minutes. The experiment therefore proved that magnesium hydroxide does not decompose cyanogen bromide to any serious extent in the way that lime does.

*Manufacture of Cyanogen Bromide.*—Until this compound was used for the purpose of gold extraction it had no commercial importance, and could only be regarded as a chemical curiosity. It was found, as soon as its use was commenced on a large scale, that owing to its poisonous nature and instability it was impossible to ship it in bulk. This created a need for a method to produce it on the mines from chemicals which were more easily handled. The production of bromine by treating a bromide with an oxidising agent and an acid was well known, and the production of cyanogen bromide by the addition of bromine to an alkaline cyanide was known almost as well, both of these reactions being easily carried out and giving very good yields. It was a simple step to combine the two reactions in one operation and obtain an equally good yield of cyanogen bromide.

The most satisfactory oxidising agent to use is the alkaline bromate, and it came into very general use. Not only does this salt act as an oxidising agent, but it also contains bromine which can be utilised in the reaction. Another advantage is that when the bromate is used there is no possibility of complicating the subsequent cyanide treatment by the introduction of other elements as there is when such oxidising agents as potassium bichromate, potassium permanganate, or potassium nitrate are used. Also when using a bromate the reaction will take place at atmospheric temperatures, whereas most other oxidising agents require the aid of heat.

If bromine is added to a solution of caustic alkali and the liquor is evaporated to dryness at a temperature of 100° C. a salt corresponding to the formula $5NaBr+NaBrO_3$ is produced, and this may be used for the production of cyanogen bromine according to the following equation:—

$$5NaBr+NaBrO_3+3NaCN+3H_2SO_4 = \\ =3CNBr+3NaBr+3Na_2SO_4+3H_2O.$$

It will be seen when this salt is used three atom bromine go to form sodium bromide instead of cyan bromide and are consequently wasted, and it is be therefore, to use a salt of a higher oxidising nature manufacturing an artificial mixture of a bromide an bromate corresponding to the formula $2NaBr+NaB$ With this salt all of the bromine contained in it is verted into cyanogen bromide according to the follow equation:—

$$2NaBr+NaBrO_3+3NaCN+3H_2SO_4 = \\ =3BrCN+3Na_2SO_4+3H$$

According to the above formula the theoretical charg manufacture 100 lbs. of cyanogen bromide is 112·3 lbs the mixed salts, 46·2 lbs. of sodium cyanide, and 92·4 of sulphuric acid. In practice the weights actually u naturally vary with the purity of the chemicals obtainal

When starting to mix the "brew" as it is commo called, the acid is first diluted by adding it to ab 100 gallons of cold water which is contained in a le lined vat with wooden stirring gear; the top of the va covered, with the exception of a small hole thro which the chemicals can be introduced. There is necessity to allow the diluted acid to cool before the o chemicals are added. The cyanide is dissolved in suffic water to make a 10 per cent solution; this is contained a separate tank situated above the mixing vat. T bromide salts are not dissolved, but are added gradu to the acid a few pounds at a time, and as soon as bromine is set free as shown by the reddish colour, su cient of the cyanide solution is run in nearly to bleach i

Care is taken during the addition of the salts a cyanide that there is always a small amount of bromine present in the mixer. That is, the bromine sal are always added slightly in excess of the cyanide. this is not done and the alkaline cyanide is allowed to in excess, mutual destruction of cyanogen bromide a alkaline cyanide will take place with the production brown paracyanogen. The time taken to add the giv quantity of bromine salt would be about twenty minut When reasonable care is taken, a very high percentage the theoretical yield of cyanogen bromide can be obtain and it is not uncommon to reach over 90 per cent. T usual solution prepared on the mines contain about 2 p cent CNBr, but if required, strengths up to 5 per ce CNBr may be prepared without reducing the yield. Wi solutions above 5 per cent the loss of volatilisation begi to be excessive owing to heating of the charge.

The reaction is a rapid one with all concentratio which yield a solution of over 0·5 per cent CNBr, a in order to show the rapidity of the reaction we will quo an experimental "brew" which yielded a 1·77 per ce CNBr solution. With this concentration we found th 89·9 per cent of the theoretical yield was obtained as so as the bromine salt had been added, and after stirring f one hour, the yield had increased to 93·9 per cent.; co tinued stirring did not show any further increase. Th rate of decomposition of solutions prepared in this man is very slow, and they will maintain their strength f some days provided they are kept in a closed vessel. It usual to add cyanogen bromide to the slime charges on basis of 100 per cent yield from the bromine salt; that to say, it is not considered necessary to make any allo ance for the bromine which is not converted into cyanog bromide during the process of manufacture.

The method of testing a solution of cyanogen bromi by titrating the amount of iodine set free after th addition of potassium iodide and acid with a N/10 solu tion of $Na_2S_2O_3$ is well known, but the mention of tw points which have come to our notice may be usefu When preparing a N/10 solution of $Na_2S_2O_3$ it is custo mary for metallurgists to standardise it against pu copper in the same way as they do when making a copp determination. (See "Rand Metallurgical Practice, vol. i., p. 364). This is accurate enough, but a ver simpler method is to standardise against a N/10 solutio

...ssium bichromate which has the property of setting ...line from potassium iodide in the presence of acid. ...r point which is very important when testing ...en bromide "brew" is that, when they contain any ...mposed bromate and excess of acid it becomes ...ry first to neutralise the acid with a solution of ...ate of soda, and afterwards slightly acidifying with acid before the potassium iodide is added, other...e bromate will itself set iodine free which will be ...ted as cyanogen bromide and consequently inflate ...ult.

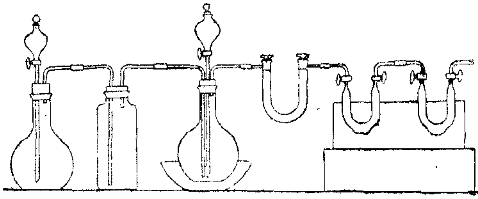
*Use of Cyanogen Chloride.*

...t of the text books on the cyanide process state or ...at the bromide, chloride, and iodide of cyanogen ... equally efficient as solvents for gold when mixed ...n alkaline cyanide in the requisite proportions. The ...the iodine compound has several times been given ...ence in the United States, but its high cost has ...ted anything more than experimental work being ... It makes a good solvent, but the cost is pro... In considering the chloride, however, the ...n of cost is very different, for chlorine is the ...st halogen, and the difference in cost is so great as ...e a stranger to the use of these compounds at once ...r *why the more expensive bromine is always used.* ...wer molecular weight of the chloride is also in its ..., for if the conditions are assumed to be equal, ...of the chloride should dissolve the same amount of ...5 lbs. of the bromide.

...eferring to standard chemical works it will be found ...yanogen chloride is described as a white compound ... in many respects to the bromide, but with a much ...melting-point, it being a liquid at $-18^{\circ}$ C. and boiling ... atmospheric temperature. The books also state ... may be prepared by the addition of chlorine water ... alkaline cyanide in the same way as the bromide ...e iodide are. Taking these facts into account, and ... in mind the low cost of producing chlorine by the ...lysis of brine, we have made a very large number ...eriments to ascertain if the chloride could not be ...nstead of the bromide, and the result of these ex...ents has been to show us that under no conditions ... we have tried can the chloride be made to give any ...ved extraction over that obtained by the ordinary ...e cyanide process.

... found that when a solution of chlorine water is ... to a solution of alkaline cyanide in molecular pro...ns there is no doubt that a chemical reaction takes ... as the green colour of the chlorine disappears, and ...esulting liquid has a pungent odour and irritating ... on the eyes, which can only be described as a very ...erated smell of cyanogen bromide. As there might ... serious loss of cyanogen chloride by volatilisation ...st tests were made in bottles. Several bottles were ...with finely ground ore pulp prepared in the same way ... successful treatment with cyanogen bromide, and ...g amounts of cyanogen chloride were added. The ...e was prepared by adding standardised chlorine ... to standardised cyanide solution in the requisite proportions. Other bottles were given similar charges of cyanogen chloride with the addition of lime, and in each series of tests a bottle was also treated with plain cyanide to create a standard for comparison of the residue. A very large number of these tests were made on a great variety of ores, but in no single instance was any benefit shown by using cyanogen chloride, whilst it always increased the cyanide consumption. The following three comparative experiments are typical of the results obtained. The ore used was a sulphur-telluride one and was slimed to all pass a 200-mesh standard sieve in a stoneware mill in order to make sure that abraded iron could not effect the results. Each of the three experiments were made on exactly similar portions of the slime, and with the same strength of cyanide solution, which contained 0·2 per cent KCN.

It will be seen that the best extraction was obtained by the use of the alkaline cyanide, and the poorest when using cyanogen chloride in acid solutions. This would appear to be caused by the cyanogen chloride destroying the cyanide, but not accelerating the solution of the gold. When sufficient lime is added to render the solution neutral as was done in experiment 3, the destruction of the cyanide is not so great, although it is still considerably *greater than when no chloride is added. The increased* strength of cyanide remaining had the effect of slightly improving the extraction and bringing it nearer to the result obtained in No. 1 experiment in which plain cyanide was used.



*Head Assay Value of the Ore 44·8s.*

| No. | Treatment. | CaO lb. per ton. | Cyanogen chloride per cent. | KCN per cent at finish. | CaO per cent at finish. | Residue shillings. | Extraction per cent. |
|---|---|---|---|---|---|---|---|
| 1. | Plain cyanide | 4 | Nil. | 0·065 | 0·02 | 9·5 | 78·8 |
| 2. | Cyanogen chloride, without CaO .. | Nil. | 0·05 | Nil. | Nil. | 21·3 | 52·4 |
| 3. | Cyanogen chloride, with CaO | 4 | 0·05 | 0·017 | 0·001 | 15·3 | 66·0 |

In these experiments when we had prepared the solution of cyanogen chloride we endeavoured to estimate its strength by the amount of iodine it would set free in the same way as the cyanogen bromide is estimated, but no reaction with the potassium iodide was obtained, although the characteristic odour of cyanogen chloride was very marked. We therefore began to doubt if any useful quantity of cyanogen chloride was formed by this method of manufacture, and taking into account the negative results obtained in treating ores, we decided to investigate other methods for the preparation of cyanogen chloride.

The literature on the subject is very extensive but is *often very contradictory, and the only reasonable method* seemed to be that given by M. A. Held (*Bull. Soc. Chim.*, 1897, xvii., 287). Held's method consists of passing chlorine gas through zinc cyanide which has been dis-

solved in a solution of sodium cyanide, and collecting the cyanogen chloride formed in a U-tube which is kept at a temperature of −20° C. In order to test this method we arranged the apparatus which is shown in the sketch. The first flask was for the generation of chlorine by the action of hydrochloric acid on permanganate of potash, and the gas was washed before it was passed into the second flask containing the cyanide of zinc. The second flask was also fitted with a dropping funnel for the addition of cyanide, and the temperature was kept at 0° C. by means of melting ice. The first U tube contained calcium chloride to absorb moisture, and the remaining U-tubes were for the purpose of collecting cyanogen chloride. These tubes were specially manufactured for the purpose and designed to stand a considerable pressure. The cyanogen chloride collectors were kept at −20° C. by means of calcium chloride and ice. We took 13·5 grms. of $Zn(CN)_2$ and dissolved it in 11·72 grms. of NaCN contained in 50 cc. of water; this solution was placed in the centre flask shown in the sketch. Chlorine gas was then passed slowly into the sodium zinc cyanide and zinc cyanide was precipitated; the precipitate was redissolved by adding gradually 20 cc. of 10 per cent sodium cyanide solution through the dropping funnel. After passing the chlorine gas for about half an hour the temperature of the flask was increased, and cyanogen chloride distilled over and collected in the U-tubes in the form of white crystals. 8·89 grms. of cyanogen chloride were obtained, and upon examination of its properties it was found to have a melting-point of −6° C. and a freezing-point of −19° C. At atmospheric temperature the liquid boiled violently, and the vapour had an intensely irritating effect on the eyes. As we desired to use the crystals in the treatment of ore slimes, they were allowed to melt by increasing the temperature, and the liquid was poured into a stoppered bottle containing ice-cold water. The quantity of water was measured so that a 2·9 per cent solution of cyanogen chloride would be formed. The cyanogen chloride fell to the bottom of the bottle as an oily fluid, which dissolved on shaking to a perfectly colourless solution showing the absence of free chlorine.

Comparative experiments on gold leaf were made with the freshly prepared solution mixed with alkaline cyanide, as compared with plain alkaline cyanide alone. A solution of cyanogen bromide was also freshly prepared and used in comparison with the cyanogen chloride. In each experiment the time required to dissolve one square inch of gold leaf was noted. In the plain cyanide experiment the gold leaf was floated on the surface of the solution in order to give it the full benefit of atmospheric oxygen.

The results were as follows:—

(*a*) With 0·2 per cent KCN 1 sq. in. gold leaf dissolved in 3·25 min.

(*b*) With 0·2 per cent KCN+0·05 per cent CNBr 1 sq. in. go d leaf dissolved in 0·5 min.

(*c*) With 0·2 per cent KCN+0·05 per cent CNCl 1 sq. in. gold leaf dissolved in 3·5 min.

From this it will be seen that no gain is derived from the use of cyanogen chloride, but that cyanogen bromide very much accelerated the action of the alkaline cyanide.

Experiments were also carried out using a solution of cyanogen chloride prepared by Held's method on ore slime which was similar in character to that which we have already described. The following table of results shows that no better extraction was obtained when using cyanogen chloride than when plain cyanide was used, and that variations in alkalinity did not affect the result. The strength of alkaline cyanide in each experiment was 0·2 per cent KCN, and the head value of the ore was 62·5*s*.

| No. | CaO lb. per ton. | CNCl per cent. | KCN per cent after treatment. | CaO per cent after treatment. | Residue shillings. | Per cent Extraction. |
|---|---|---|---|---|---|---|
| *a* | 6 | Nil | 0·092 | 0·023 | 15·9 | 74·5 |
| *b* | 6 | 0·05 | 0·062 | 0·006 | 16 0 | 74·4 |
| *c* | Nil. | 0·05 | 0·022 | Nil. | 16·7 | 73·2 |
| *d* | 2 | 0·05 | 0·060 | Nil. | 16·0 | 74·4 |

Although the crystals of cyanogen chloride which prepared by Held's method had all the properties which this compound is usually credited, it did not the property of setting iodine free from an acid sol of potassium iodide, thus confirming our previou perience that cyanogen chloride cannot be estimat the same way as the bromide. Its failure in answ to this test prevented us from estimating how cyanogen chloride would exist when mixed wit alkaline cyanide in the same way as was done wit bromide. An approximation was obtained by comp the rate at which it would decompose alkaline cyani compared with similar decomposition caused by cyan bromide. Two mixtures were prepared, the first conta 0·2 per cent KCN and 0·03 per cent CNCl, and the se containing 0·2 per cent KCN and 0·05 per cent C The smaller percentage of cyanogen chloride was tak allow for the lower atomic weight of chlorine bromine, and, in consequence, if the two haloid pounds act in the same way we should expect tha standing, the consumption of cyanide in each case w be the same.

The following are the results:—

*Separate Cyanicide Effects of Cyanogen Chloride a Cyanogen Bromide.*

| Time in minutes. | Mixture containing 0·2 p.c. KCN+0·03 p.c. CNCl KCN p.c. remaining. | Mixture contain. 0·2 p.c. KCN+0·05 CNBr KCN p.c. remain |
|---|---|---|
| 5 | 0·182 | 0·182 |
| 10 | 0·169 | 0·182 |
| 15 | 0·162 | 0·175 |
| 20 | 0·156 | 0·173 |
| 25 | 0·149 | 0·175 |
| 30 | 0·149 | 0·175 |
| 40 | 0·143 | 0·175 |
| 50 | 0·143 | 0·175 |
| 60 | 0·143 | 0·169 |
| 90 | 0·130 | 0·157 |
| 120 | 0·130 | 0·149 |

These results show that the chloride destroyed cyanide more rapidly than the bromide, but the rat decomposition was less than we had expected. A from the cyanide tests there was ample proof that cyano chloride existed in the solution for some considerable ti as its effect on the eyes continued to be very marked the tests showed no further reduction in the strengt potassium cyanide. We have shown, therefore, that rate of decomposition of cyanogen chloride is not so as to prevent it being a solvent for gold in the same as the bromide, and that some further explanation of failure is required.

Our investigations have shown that there is no g difficulty in preparing cyanogen chloride, but all en vours to utilise it as a gold solvent have met with fail The reason for the difference in action between the chlo and bromide may at a later date be explained by result of further investigation; but the chances of cya gen chloride ever being utilised as a commercial g solvent are at present remote.

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ADVERTISING MEDIUM IN POLAND.—A circular has b issued by the Polish Merchants' Association, regardi their publication entitled *The Warsaw Weekly Review Commerce.* The office of His Majesty's Commer Secretary at Warsaw states that the paper is to be stron recommended as a medium of advertisement in Pola It is now available for loan to such firms in the provin as may make application for it to the Department Overseas Trade, 35, Old Queen Street, S.W.1. A communication regarding the insertion of advertisi matter in this publication should, of course, be address direct to the publishers, ***Warsaw Weekly Review Commerce*** **(Tygodnik Handlowy), 10, Szkolna Str Warsaw.**

## CONSCIOUSNESS AND THE SCIENTIFIC SPIRIT.*

By the Rev. WILLIAM FLINT, D.D.,
...t of the South African Association for the Advancement of Science.

the scientific spirit can with advantage be applied consideration of problems other than those which ...erely physical is evidenced by the development of ...ch investigation in matters pertaining to race and ...ality which grow out of ideas rather than physical ...ions. The study of race questions necessitates ...g due allowance for such natural facts as are con... with the human organism, its history and its ...t, but psychological and ethical factors are found to ...le themselves so often that no adequate account can ...en of race-consciousness without allowing fully for ...arts played by these. The facts concerning man ...t be so isolated and submitted to the processes of ...ysical method as to enable us to state "This is," ...it is not," and to predict with certainty that given ...nations will produce unvarying results. The social ...ier, the Parliamentarian, the diplomat have no ...tories in which they can produce results akin to ...of the synthetic chemist, but they can emulate his

In discussing questions pertaining to race we are ...aling only with matter, even sentient matter. There ...it is termed human nature involved, and it is impos...o proceed far in any direction without the physical ...ry merging into a metaphysical discussion. A new ...ss of separating and refining gold may be so demon...d as almost to compel its acceptance throughout the ...where similar conditions exist, but there is no exact ...e of human nature which will enable us to invent, ...er, or apply tests which will be invariable in their ...tion, and so enable us to bring about improvement ...ults which we are seeking. Still the questions to ...science may assist in finding an answer are ...rous, and the aid of the scientific spirit especially ...d prove of very real value. If it be asked wherein ...lvantage of that spirit consists, let the answer be ...in the work of a Lister, a Pasteur, a Curie, an ...n. These, whose discoveries and applications of ...ledge are lauded by the world, sought for truth in ...; they sought it fearlessly, they applied it honestly, ...they did not expect satisfactory results if they ...cted, ignored, or defied the facts which they verified. ...roblems in the field of human nature are of a different ...cter to theirs, but who shall say that they are not ...readily soluble than we have found them hitherto ...roached in the same spirit? But that spirit must ...le an unwavering desire and determination to know, ...ved by an unfaltering courage to apply the know...gained. At the back of the scientific spirit there ...ays the definite assurance that Nature cannot be ...d. The experiment which is not wholly honest pro... no reliable result. Any earnest study of man in ...pirit will reveal some facts relating to his being which ...be definitely verified, and these being established ...a not altogether useless contribution to the practical ...of questions rising out of race interests, race pre...s, and concurrent matters. On the other hand, a ...y physical investigation does not explain race con...sness, or suggest a remedy for the problems which ...consciousness creates. When physical science has ...its best there will still be found that in human nature ...does not react to any physical test. Yet when it ...ted that the physicist deals with facts and the meta...cian with words the distinction is unworkable. ...ls are the symbols of facts, and things, and their ...rties; and race-consciousness is a property of human ...e for which the merely physical does not adequately ...nt. Science has been defined as organised know..., and the first step towards the solution of the problems before us is the knowledge of what race-consciousness really is.

I. The first outstanding fact which should be noted concerning the human race is its unity.

A typical man of any race regarded from any point of view—physical, mental, moral—will stand forth as having characteristics which are representative of every normal member of the human race.

(a) Take his organic form. Morphologically the development of the human of any race as a living organism speaks of unity.

(b) The same is true when he is viewed physiologically. A consideration of the processes and functions of the parts of the human organism testify to solidarity.

This, if pressed, may perhaps tend to lead a little far for the comfort of some who are sensitive in regard to their kinship with certain sections of the animal creation, but after all we are animals. Still we are animals with a difference. An elephant is not a giraffe, and a man is not an ape, however much he may resemble one. The implications of the unity of man do not include his complete unity with the highest order of the animal creation outside of his own, because they include more than that. There are no transactions yet produced by a Society of Apes for the Advancement of Science, but the lowliest form of man yet discovered may be conceived of as a rudimentary scientist. He gives evidence of studying the markings, habits, and haunts of the animals he kills, distinguishing those he likes best, communicating his knowledge to his fellows, and working in concert with them to secure what he requires, or to save his food-stocks from being killed off too rapidly, or even killing other beasts which prey upon them; improving and adapting from time to time the implements with which he does this, and leaving records of his methods in the rich stores of his kitchen middens and in his graphic rock paintings: all of which is a rudimentary association for the advancement of science. There is pure science in the knowledge of fact, and applied science in the wisdom of action.

It is, however, not a principal part of this enquiry to enlarge on the essential unity of the human race, or to dwell upon the points in which it is differentiated from the rest of the animal creation. Through the ages various and subtle processes have been at work to produce new expressions of the form divine, and at the same time powerful counteracting influences have been labouring to bring about reversion to type. There are suggestive theories regarding the origin of, and the purpose in, all this, some purely materialistic and others giving large place to the work of mind and spirit. They can barely be mentioned here—

A fire, a mist, and a planet,
  A crystal, and a cell,
A shellfish and a saurian,
  And a cave where the cave-men dwell.
Then a sense of law and beauty,
  And a face turned from the clod,
Some call it "Evolution,"
  And others call it "God."

An older literature begins its story—"In the beginning God created the heaven and the earth." "And God said, Let us make man in our image, after our own likeness."

What has to be borne in mind is that behind all race-consciousness is this unity. That is an essential factor in its content, and our observations, conclusions, and actions, if animated by the scientific spirit, must never lose sight of its implications.

Anomalous as it may seem, it is what all men have in common because of the solidarity of the race which produces the problems arising out of the diversity which time and circumstances have brought about. The primary reason why the races struggle and fight with each other is not because they differ, but because their fundamental similarity and oneness will not admit of one being dominant over the other.

* Delivered at Kingwilliamstown, S.A., 1919.

II. If the unity of the race stands out with such distinctness no less clearly is its diversity apparent.

It is in our association with this latter we find the difficulties of race-consciousness first making their presence felt, and under two distinct sets of circumstances—(i) as between different sections of the European peoples, (ii) as between white and coloured races.

(i) The consciousness of diversity as between different sections of the European peoples.

The examination of that has not proceeded far before it is found necessary to distinguish between what is the result of heredity and what the consequence of environment, when it will be seen that what may have originated in race-consciousness in earlier times is now little more than national consciousness in many instances. The proclivities which have come along the line of physical descent are not easy to distinguish from mental proclivities more recently received. A child receives from environment certain mental suggestions which seem to be of nature, but are not necessarily so, as is witnessed by the ideas of a similar child in another environment. We have not forgotten W. S. Gilbert's apt hint of how prejudices may, under certain conditions, become stereotyped in families—

> I often think it's comical
> How Nature does contrive
> That every boy and every gal,
> That's born into this world alive,
> Is either a little Liberal,
> Or else a little Conservative.

*In many a well-known English family* in a past generation that seemed quite apparent, and yet, of course, it was not true. Environment and mental suggestion were the factors at work. In the hundred and one little antipathies which exist between the individuals of different races and nationalities this much seems evident: that as between the race-consciousness, of which colour is the outward and visible sign, and that as between the white peoples themselves, there is certainly a difference of high degree or even of nature. Dealing with the latter, it suffices to state that no very clear line of distinction can be drawn between Race, Nationality, or even Statehood, which will alone account for the differences and prejudices which exist between the several peoples of Europe. There are questions of language, territory, natural or artificial boundaries, hereditary rulership, and many other factors all involved to such an extent that what is at first deemed to be race-consciousness very frequently proves on a closer examination to be something far more recent and artificial than that.

The historical development of a people producing national identity is conditioned not only by natural heredity and environment, but also by ideas superimposed upon these, and the growth and influence of the last-named are extremely subtle. As exerting a natural force geography accounts for much that is peculiar to certain peoples, though it is a long story to trace, for *instance, the growth of the characteristics of an island* people through the ideas growing out of fishing and sea-faring habits which have hardened into propensities. Moreover, it has to be remembered that there are forces which work in an opposite direction with an equally powerful effect, as witness the case of the Jews by the force of ideas preserving a race intact through all the years in defiance of geography.

Ideas come from many sources, such as the habits and occupations of the people. The history of a country like Great Britain reveals how economic conditions bring about easily recognised changes in physical and mental type, having many advantages in transmitted capacity and adaptability for the particular difficulties involved in the occupations concerned, thus in a particular sphere producing a very definite form of consciousness. As to its nature, it may be noted that the content of the consciousness will often be found marked by ideas which have a narrowing effect upon life as a whole. But let n elements be introduced, or new industries which readjustment of outward relationships and an ment of the circle, the very friction and criticis duced by this will stimulate a further life. A nationality like that of the English has recei marked and definite enrichment from those w been welcomed from other lands through the poli open door, but whose numbers at any one time been so great as to prevent them from being into the body politic. Therein is a lesson f nations, anxious to broaden their life while retaini identity. A distributed settlement may be inco at first for the settlers, but if they come from a behind in civilisation it is better for them and th their adoption that they should not constitute c separate and possibly disaffected nationalities a narrowing influence. Both their descendants country and its people gain by absorption, a n influence being thereby transformed into a b and stimulating element. Of this there are illustrations in Europe Distinct groups of peo the marks of successive influences from the vario named. So it may be affirmed that national consc as found in Europe, reveals the fact that, while t strong race traits still present, race and nationalit the European peoples can rarely be regarded as i The most diverse ethnological elements are inc blended. Doubtless in certain sections of t tinent there are craniological peculiarities testify of Eastern origin and elsewhere distin colouring, which tell of journeyings from the ea no nationality is so free from exceptions to either as to make race and nationality one. Sweeping sations regarding populations may serve a politi pose, but they fail in the exactitude which demands. Whole sections of population in so have a consciousness much more affected by than race, while in many instances the conscio much more political than racial, having been c the vertical divisions set up by astute and sel rulers. An illustration of this is seen in the car of such maxims as those left by Frederick the G the guidance of his successors.

(To be continued)

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# PROCEEDINGS OF SOCIETIE

## ROYAL SOCIETY.

*Ordinary Meeting, March 4, 1920.*

Sir J. J. Thomson, O.M., President, in the C

The following papers were read :—

"*The Protoplasmic Factor in Photo-synthesis.*" F. F. Blackman, F.R.S.

The centre of interest in problems of th reduction of $CO_2$ in green photo-synthesising shifting from the chlorophyll to the protoplas quantitative control of photo-synthesis in the green cell is determined protoplasmically. illustrated by the temperature relations which are no a photo-chemical reaction, but of a dark reaction. T synthetic activities of leaves of different varieti e. golden leaves) and at different stages of dev show no relation to the amount of chlorophyll contain, as is brought out by the "assimilation n of Willstätter. The relation between chlorophyll ment and photo-synthesis development, describ next communication, furnishes another instanc dominance of factors other than the pigment.

ny lower organisms we find the power of reducing form organic matter by chemical energy in the of pigment or light. This chemo-synthesis may ile or only an alternative source of the carbon for g cell. The process involves, of course, no cosmic energy. In these cases the efficiency of energy nce from the oxidation of various substances to ction of $CO_2$ seems to be as great or greater than utilisation of light energy for photo-reduction

*Beginning of Photo-synthesis in the Green Leaf.*" :. BRIGGS.

ung leaves development of the power of photo-s is found to lag behind development of chloro- that a green leaf when young may exhibit very r zero photo-synthetic power. This means that nthetic activity demands development of some ternal factor than chlorophyll. The potentiality ther factor rapidly increases with age day by day, en the leaf is kept in darkness continuously. By a leaf in a very low partial pressure of oxygen development of chlorophyll can be completely , even in continuous light. Here also, starting leaf of feeble green tint there is similar, day by rease in photo-synthetic power, in spite of there further greening.

iments were carried out by means of a new 1s designed by Dr. F. F. Blackman for measuring output of oxygen in photo-synthesis. The leaf is ted in a closed circuit in an atmosphere of hydrogen bon dioxide. In part of the circuit gases are over palladium black, so that oxygen produced with two volumes of hydrogen. The three-fold n of volume resulting is measured by a gas burette rcuit. *In this apparatus oxygen pressure is kept* hat no further development of chlorophyll takes hile photo-synthetic production of oxygen can be d with great accuracy.

af is cut from a seedling growing in the dark at stage of development, and then partly greened by e to light in air, its photo-synthetic activity when ed to the apparatus will be very small or nothing. ly the same procedure is repeated a few days later o-synthetic activity may be nearly as great as in nally developed leaf.

*light and the Life of the Sea.*" (Studies of the ynthesis in Marine Algæ. (1) Fixation of Carbon trogen from Inorganic Sources in Sea-water; (2) of Alkalinity of Sea-water as a Result of Photo-is and as a Measure of that Process; (3) Relative ynthetic Activity of Green, Brown, and Red Sea-a Light of Varying Intensity). By Dr. BENJAMIN F.R.S., E. WHITLEY, and T. A. WEBSTER.

ernal outburst of green life which occurs at the equinox is occasioned by the rapid change in in-of daily illumination.

dy of the seasonal variations in plankton around in, Isle of Man, has now been carried on for many Prof. W. A. Herdman and his co-workers.

any years the great outburst of diatoms occurs he temperature of the water has even begun to om its winter level. It thus becomes clear that it onger brighter day, with increased altitude of the ich is the primary factor in the sudden dawn of the he sea each spring.

*is illustrated by the chart (lantern) upon which are* or each month:—(1) Temperature of the sea; (2) of diatoms; (3) hours of bright sunshine; (4) liant energy; (5) the amounts of nitrogen peroxide in the air (formerly called "ozone of the air" or oxygen"), as taken at Radcliffe Observatory, by Schönbein's "Ozone" papers.

ve the sudden rise in radiant energy in March, and is accompanied by (1) the diatomic outburst, and ased nitrite content.

It has been shown that the growing diatoms capture this enormous increase of light, and utilise it for building both carbon and nitrogen into their organic substances.

The source of the nitrogen is the atmospheric elemental nitrogen dissolved in the sea-water, and not ammonia, nitrites, or nitrates. The source of the carbon is the carbon dioxide of the bicarbonates of calcium and magnesium dissolved in sea-water.

As this carbon is removed in photo-synthesis the sea becomes always more alkaline, and the change of reaction can be used as a rough measure of the marine crop. Although the increase of alkalinity is small, yet the volume of sea-water is so immense that, as has been pointed out by Moore, Prideaux, and George Herdman, supposing this to happen to a depth of 100 metres over the surface of the sea, then the crop of moist plankton per square kilometre would amount to about 1,500,000 kilogrms. This corresponds roughly to about 10 tons per acre.

## PHYSICAL SOCIETY.

*General Meeting, February 27, 1920.*

Prof. W. H. BRAGG, F.R.S., President, in the Chair.

A PAPER entitled "*The Balancing of Errors*" was read by Mr. T. SMITH, B.A.

In calculating functions from Taylor expansions or otherwise, the results obtained by summing any finite number of terms will differ to a greater or less extent from the true results. It is shown in the paper that by suitable modifications of the coefficients the results obtained, even when comparatively few terms of the expansion are taken, can be made to approximate very closely to the true results for all values of the variable between selected limits.

Mr. F. J. W. WHIPPLE asked why, when terms of higher order than $n$ were to be neglected, the author found it advantageous to use $n+2$ points rather than $n+1$.

Mr. SMITH said it could be shown that the maximum accuracy was obtainable by taking $n+2$ points and giving equal and opposite errors at alternate points. He added that it was possible by the method of the paper to represent a function which it was impossible to expand. As an example he mentioned the common logarithms from 1 to 10. Any ordinary expansion would be divergent over this range.

A paper entitled "*Notes on the Testing of Bars of Magnet Steel,*" by Dr. N. W. MACLACHLAN, was read by the Secretary.

The paper describes the results of experiments with the Ewing double permeameter. It is shown that the assumption underlying the theory of the method—viz., that the end effects are the same with the long and short bars—is not justified, and that the value of H, as found by *calculation on this assumption, is in error.* The error did not, however, exceed 1 per cent for any of the bars tested; but the author concludes that the method is inferior as regards accuracy and convenience to the differential coil method.

Dr. D. OWEN said it was evident that the leakage did not occur only at the yokes, but began near the centre of the bars. The applied field would therefore be strongest at the centre, so that, taking the average field, as done by Ewing, would give too low a value.

A paper entitled "*On the Forces Acting on Heated Metal Foil Surfaces in Rarefied Gases,*" was read by Mr. G. D. WEST.

The present paper arises out of two previous papers by the author on the pressure of light (*Proc. Phys. Soc.*, 1913, xxv., 324, and 1916, xxviii., 259), and consists of an experimental investigation of the nature of certain peculiar movements of strips of thin metal foil surrounded by rarefied gases, and exposed to radiation. The experiments deal chiefly with phenomena at gas pressures below

1 cm. of mercury, and it is shown that the apparently diverse results obtained can be connected by a theory based on the work of a previous paper (*Proc. Phys. Soc.*, 1919, xxxi., 278).

The author concludes that, at the highest rarefactions, the pressures on the strips arise from the fact that, if differences of temperature exist in an enclosure, the pressure of the gas is not uniform, but varies approximately as the square root of the latter's absolute temperature. The simple conditions that exist at low gas pressures are complicated, at the higher pressures, by gas currents which differ fundamentally from convection currents, but which are closely connected with the phenomena of thermal transpiration.

Prof. ECCLES said be was indebted to the author for his elucidation of gas action effects. He had frequently been puzzled by them in the past when designing certain instruments. In the curves shown the maximum effects occurred at a pressure of about 1/100th cm. of mercury. What ratio did the mean free path of the gas at this pressure have to the distance between the foil and the glass plate? Had this ratio any particular bearing on the gas action being a maximum?

Mr. WEST—The ratio was about one-sixth or one-fifth, though he could not be quite certain without reference.

Mr. F. E. SMITH said that the author had experimented with two widths of foil. He suggested that experiments should be made with a series of strips of different widths and a curve obtained connecting the width of the strip and the deflection.

Mr. WEST said he had done this, but, except for broad strips, it was impossible to be certain that the temperatures were the same as the disposition of the stream lines was different. It was necessary, therefore, to reduce the results to deflections per degree rise of temperature of the strip. At present his method of reduction was only rough, but the results showed that if the width of the strip is not comparable with the mean free path, the effect decreases as the width is diminished.

Mr. F. J. W. WHIPPLE mentioned that when the author read his last paper, Mr. Lewis Richardson also read one describing a new manometer. He gave a diagram connecting the force on the circular diaphragm of his instrument with the pressure, and afterwards he (Mr. Whipple) had compared Mr. West's transpiration theory with Richardson's diagram. According to the theory, the annular channel in the manometer was equivalent to a tube of 7 cm. diameter, which agreed very closely with the actual dimensions of the annulus. This appeared to afford confirmation both of Mr. West's theory and of Mr. Richardson's measurements.

# CORRESPONDENCE.

## ISOTOPES.

*To the Editor of the Chemical News.*

SIR,—In *Nature* of March 4, 1920, I note that Dr. Aston records the discovery of further isotopes. Argon appears to have isotopes 36 and 40, the latter giving a strong line as there are relatively fewer of the former atoms present, the mean atomic mass being 39·90. So far, the isotopic duality supports the cyclic scheme of evolution—see CHEMICAL NEWS, 1920, cxx., 73—but krypton, xenon, and mercury have apparently considerable numbers of isotopes, the values being:—

Krypton—78, 80, 82, 83, 84, and 86.
Xenon—128, 130, 131, 133, and 135.
Mercury—202 strong line, 204 weak line, and 197 to 200 strong band.

While the mean between 202 and 204 is 203, and similarly the mean between 197 and 200 is about 199, and these means are figures I have provisionally evaluated for mercury (see citation above), there are obvious ob to such a calculation; and it seems to me that h may be attached to some of these atoms, very r $H+H_2$ might yield $H_3$. (By the way, Dr. Ast that $H_3$ is proved without doubt, and the v hydrogen, 1·008, is confirmed). This consideration does not tend to disprove the possibility that the tl whole-number isotopes is unsound, but that some values will require further investigation before they accepted, unless every possibility of pseudo hydride formed has been eliminated. The inactive gase even form transient compounds of this type, certain carbon compounds of hydrogen are recorded positive-ray plates; *i.e.*, compounds which are not to the chemist. No doubt Dr. Aston has investiga possibility, and doubtless this question will be dea in due course.

There are two other points of possible interes ferring to the diagram in the paper cited above copper-bromine loop be extended to intersect th valency line, krypton should have possibly four is The same remark applies to xenon. The loops w drawn with any attempt at accuracy as there v values known at the time except those of neon. R to the CHEMICAL NEWS, 1915, cxi., 181, I sugg supplementary-loop system, which would, of cour to account for the multiplicity of isotopes in certai *Six isotopes might thus be the upper limit and lower*, but it is perhaps just as well to await furthe before discussing the theoretical side of the pheno as *the really important matter is the experiment* Readers of the CHEMICAL NEWS may, however, terested in isotopes as they seem destined to play portant part in chemistry and physics.

Dr. Aston now adds nitrogen to the list of e without integer isotopes—as should be expe I am, &c.,

F. H. Lo

## TIN-PLATE SCRAP.

*To the Editor of the Chemical News.*

SIR,—I shall be obliged if any reader can refer recent literature on the recovery of tin from t scrap; preferably with full details of plant, outp working costs, &c. Any information on the subj be welcome.—I am, &c.,

E. L. B

24, Tynevale Terrace,
Lemington-on-Tyne.

# NOTES.

POTASH IN GERMANY.—According to the *l Tageblatt* production conditions in the potash i have very considerably improved in recent months. especially due to the fact that there has been a co able improvement in the supply of coal for some tin At the present time representatives of the Potash Sy are on their way to the United States with the ol concluding a running contract for the delivery quantities of potash salts. The prospective pri described as remunerative. Special quantities of the manufacture of the export consignments in q are to be supplied to the potash works. Amer declared her readiness immediately to place at dis part of the amounts payable for the potash sup *Reuter's Trade Service.*

IN view of the dislocation of business in Brit gineering workshops by the recent disastrous s moulders, the Directors of Barimar, Ltd., 10, Street, London, W. 1, are granting a limited nu licences to engineers and founders in England, S

and Wales to use their special metallurgical pro- r salving scored bore cylinders (air-cooled and oled) and defective castings in all metals. These ; greatly facilitate production in all industries, nany, particularly in the manufacture of motor der quite unnecessary many cumbersome, expen- rations which in recent years have greatly d and delayed owners of motor vehicles. Some f work that formerly took months can now be with completely satisfactory results in as many practically any engineer or any garage owner after tuition. This successful remedy for defective is the outcome of research work conducted by wn British metallurgists. The more elaborate ly skilled welding work will be carried out as exclusively by Barimar's Scientific Welding who will also continue to repair scored cylinders cted castings for those who do not take out

INSTITUTION.—*The following are the lecture* nents at the Royal Institution after Easter:— , W. C. Kaye, two lectures on "Recent Advances y Work"; Prof. Arthur Keith, four lectures on Ethnology—the Invaders of England"; Major nglis, two lectures on "The Evolution of large onstruction"; Mr. Sidney Skinner, two lectures Ebullition and Evaporation," (2) "The Tensile of Liquids"; Mr. R. Campbell Thompson, two on (1) "The Origins of the Dwellers in Meso " (2) "The Legends of the Babylonians"; Mr. aves, two lectures on "Welsh and Irish Folk with musical *illustrations*); *Prof. W. H. Eccles*, ures on "The Thermionic Vacuum Tube as , Amplifier, and Generator of Electrical Oscilla- Mr. Frederick Chamberlin, two lectures on "The Character of Queen Elizabeth"; Prof. Frederic , two lectures on (1) "A Philosophical Synthesis sed by Auguste Comte," (2) "The Reaction and s of the *Positivist School of Thought*"; *Prof.* eans, two lectures on "Recent Revolutions in Science," (1) "Theory of Relativity," (2) of Quanta" (The Tyndall Lectures). The vening meetings will be resumed on April 16, of. J. A. McClelland will deliver a discourse on d Nuclei." Succeeding discourses will probably by *Prof. H. Maxwell Lefroy, Prof. F. O. Bower*, t Hon. Lord Rayleigh, Prof. Karl Pearson, Prof. ming, Prof. W. L. Bragg, and other gentlemen.

SSIONAL FEES.—The Council of the Institute of y have received many communications relating to for analyses and investigations at present charged e practitioners. Having regard to the facts that, on to the increased cost of living, practising have to pay higher salaries to their assistants and he enhanced cost of apparatus and materials, the are of opinion that Fellows and Associates are in making a corresponding increase in their fees ssional services.

AY SOCIETY.—A general discussion on "Basic heir Production and Utilisation in Agricultural er Industries," will take place on Tuesday, 3, 1920, from 7 30 to 10 30, in the Rooms of the y Society, *Burlington House, London, W. 1.* The me is as follows:—

F. G. Donnan, Ph.D., F.R.S., Vice-President, ill preside over the discussion.

*J. Russell, F.R.S., will open the discussion and* ve a general survey of the subject.

C. H. Desch, Ph.D., D.Sc., will discuss the bject from the *Physico-Chemical standpoint.*

H. Middleton, K.B.E., will read a paper on "The ational Aspects of the case for Increasing the pplies of Basic Slag."

Daniel Hall, K.C.B., F.R.S., will read a paper "The Demand for Basic Slag."

Prof. D. A. Gilchrist will read a paper on "Basic Slag and its place in the Development of Agriculture."

Mr. G. Scott Robertson, M.Sc., will read a paper on "A Comparison of the Effect of various Types of Open Hearth Basic Slag on Grassland."

Dr. J. E. Stead, F.R.S., Mr. F. Bainbridge, and Mr. E. W. Jackson, F.I.C., will read papesr on "Solubility of Basic Slags."

Mr. Daniel Sillars will read a paper on "The Formation of Basic Slag in the Manufacture of Steel."

Mr. W. S. Jones will read a paper on "The Improvement of Low-grade Basic Slag."

The following will also probably take part in the discussion:—Mr. E. Bury, Mr. W. Wilson, Mr. C. Davidson, Dr. B. Dyer, Mr. E. H. Saniter, Dr. W. H. Hatfield, Dr. G. Stubbs, Mr. W. A. Caddick.

## MEETINGS FOR THE WEEK.

*Tuesday, March 23.*

Royal Institution, 3. "British Ethnology," by Prof. Arthur Keith.
Institution of Civil Engineers, 5.30.
*Royal Photographic Society*, 7.
Faraday Society, 7.30. General Discussion on "Basic Slags."

*Wednesday, March 24.*

Royal Society of Arts, 4 30. "Industrial Lighting in its relation to Efficiency," by Leon Gaster.
Geological Society, 5 30.

*Thursday, March 25.*

Royal Society, 4.30. "Note on the Central Differential Equation in the Relativity Theory of Gravitation," by Prof. A. R. Forsyth. "The Frequency of Earthquakes in Italy in the years 1896 to 1914," by R. D. Oldham. "New Apparatus for drawing Conic Curves," by A. F. Dutton. "Experimental Determination of the Distribution of the Partial Correlation Coefficient in Samples of 30," by Captain J. W. Bispham, R.E.
Royal Institution, 3. "The Hope for Russia," by Stephen Graham.
Chemical Society, 5. (Annual Meeting).
Institution of Electrical Engineers, 6.
Institution of Mechanical Engineers. (At Manchester, at 7; at Birmingham, at 7.30).

*Friday, March 26.*

*Royal Institution, 9. "The Scientific Work of the late* Rt. Hon. Lord Rayleigh," by Sir J. J. Thomson.
Physical Society, 5.
Institution of Mechanical Engineers, 7.
Institute of Metals, 7.30. (At Sheffield).

*Saturday, March 27.*

Royal Institution, 3. "Positive Rays," by Sir J. J. Thomson.


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E CHEMICAL NEWS.

VOL. CXX., No. 3128.

## E CONSCIOUSNESS AND THE SCIENTIFIC SPIRIT.*

By the Rev. WILLIAM FLI NT, D.D.,
ent of the South African Association for the Advancement of Science.

(Concluded from p. 123).

possible, the powers of Europe should be made as against one another, in order to give occasion for when the opportunity arises.

understand by the word 'Policy' that one must it his study to deceive others.

orm alliances only in order to sow animosity."

history of Germany since Frederick reveals how in generations a definite form of national consciousnay be created in a people by a conspiracy or com on of the rulers and teachers of the nation to make ain set of ideas dominant.

what heterogeneous elements a European nation is osed has been graphically set forth by Henry Fabre, of his own France writes:—

ng ago, it used to attract the sea roving Phoenicians, eace-loving Greeks, who brought us the alphabet, ine, and the olive-tree; the Romans, those harsh , who handed down to us barbarities very difficult to ate. Swooping on this rich prey came the Cymri, eutons, the Vandals, the Goths, the Huns, the Indians, the Suevi, the Alani, the Franks, aracens, hordes driven hither by every wind that . And all this heterogeneous mixture was melted and absorbed in the Gallic nation.

en an attempt is being made to set the European in order at the present time it is not a little strange wo conflicting principles should be seen at work in esent peace-efforts—the self-determination of small alities, which is in danger of becoming a fresh sis of the vertical divisions between the several s; and the working out of a League of Nations, can only be effective through the development and tion of the lateral interests of the people as a whole. failure of the form of civilisation which has hitherto dominant in Europe, and which has culminated in eat war, is self-evident. What is not always as recognised is, that it is, and must always be, the il-effect of excessive and self-contained national ousness, however brought about, to produce condi- which make war inevitable, unless checked by racting forces. In the case of a small people an isised nationalism may turn in the direction of iveness which entails atrophy, but in the case of a nation, alert, ambitious, and progressive, it is much likely to produce a type of imperialism, which in its ill be productive of all sorts of antagonisms. Exces- ationalism may produce intensive culture, good and ssive for a time, but let the excess develop into iveness, and the effects can only be detrimental. pe of the future lies in the reception and assimila- f new immigrants and new ideas, and a true under- ng of the relation of the part of humanity to the . The hope for the great nation is that its conscious- hall be made to tend in the direction of federation -operation. Signs are not wanting that there is a tendency in that direction to-day, and that what I have termed the lateral interests of humanity may be more and more substituted for the vertical divisions. Such a spirit is to the forefront in the various pleas which are being put forward for the recognition and emphasis of the universal character of such human interests as are to be found in labour, the conditions of industry, food production, the health of the people, education, religion, literature, social amenities and civilisation in general. All of which means the development of an international consciousness, which after all points in the right direction, if the solidarity be accepted. This at least must be conceded, that biologically there is little justification of the limitation of outlook and interest so often present in the artificial relationships which have hitherto existed between different peoples.

This need not impinge upon a natural and commendable love of country. True patriotism is a noble quality, and when kept free from selfishness and greed is productive of the loftiest ideals and the divinest sacrifices. It engenders a healthful spirit of emulation, and like the life-blood coursing through the human body, reaches the remotest member of the nation in the most distant land, and warms in him the consciousness of having a share in a national heritage, and his own little measure of responsibility in upholding the best of its traditions. But the perils of excessive patriotism are many and great. To unduly differentiate between our own nationality and that of other people tends to the fault of giving an unnatural stress to the word "foreign," and to the development of excessive means for self-protection, which may easily become militarism. It may be that the respect begotten by fear has its value, but it can never be the highest kind of respect, and the defence of States against each other must rely more and more in the future on the development of lateral interests, and that consciousness begotten by the international spirit, which can only be attained by an honest regard for the rights and feelings of others.

The egoism of states, of races, has its good side, as in the liberty-loving consciousness of the British and American, but such egoism is always in peril of being manifested, under provocation, in ways which, while giving freedom in one direction, may take it away in another.

It must ever be a defective patriotism from the standpoint of the scientific spirit which includes only the love of its own nation as worth consideration. Science demands the recognition of all the facts, and one very real fact must always be the patriotism of other people, patriotism as a lateral interest. A patriotism which is merely French, or German, or British, or even South African, carries its own retribution, narrowing its own outlook and creating potential foes.

To lessen the evils of national consciousness may not be an easy task, but it is of some assistance to remember that ideas and prejudices, however deeply rooted, do not necessarily remain stable, and one hope of the human race tending to international amity is that the race permeated with the idea of its own unity shall strive after a larger unity of aim in the solution of the great social problems of humanity, which, after all, concern the people more closely than mere boundaries, or dynasties, or even forms of government.

In the past, too often, national consciousness has unfortunately become identified with national selfishness, and though the words of Stuckenberg may be strong, they are, nevertheless, only too true: "An unprejudiced reading of history establishes one thing beyond all controversy: their power and magnitude and selfishness have often made the States, in their treatment of each other, the worst pirates, the most unscrupulous robbers, the most cruel oppressors, and the most brutal assassins." The desire on the part of one nation to advance its own fancied interests regardless of the interests of others, or the necessity of defending the interests of the nation against the attacks of other nations with specially exaggerated ideas of personal interest has produced disaster.

With the interests of despotic dynasties largely elimin-

* Delivered at Kingwilliamstown, S.A., 1919.

ated a reduction of the war-making elements in the world has now taken place, and it is for humanity to ensure that they are succeeded, not by other elements pointing in the same direction, but by such peace-securing elements as will stabilise the peoples. Again, this reminds us that attention to the lateral human interests of the peoples in all communities must more and more engross our attention if security is to be ensured.

An apt illustration of the contrast produced by attention to such interests, as distinguished from vertical divisions of different peoples, is seen in the respective relations of Scotland and Ireland to England at the present time. In the case of Scotland the truth was long since discerned that the future progress of its people was to be found along the line of interests belonging to the people as men and women, and not merely as Scottish folk, with the result that Scotland has contributed to, and shared in, the advance which the past century has brought to the British Empire to an extent far beyond her proportionate numbers; while Ireland, with her eye on the vertical divisions, has been brought into her present unhappy position.

So it may be concluded that national consciousness, as developed by the chief and ruling place being given to barriers, dividing lines, and other vertical divisions of separation, has a tendency to over-assert its own special characteristics, to endeavour to bring others into conformity thereto, and in doing so to make the interests of others continually subservient; whereas a candid recognition of what is distinctive and valuable in others, and a cultivation of the spirit of tolerance, reveals how the lateral interests of humanity are those which are most deeply seated and of abiding importance. It is this which the scientific spirit enforces upon our attention in bidding us take into account all the facts, and keep them before us all the time. The universal is substituted for the particular, and though every nation may rightly cherish its own ideals, it discerns the fact that in the spread of these through peaceful means its own and the world's highest interests are to be found.

These are some of the factors which, neglected in the past, or thrust into the background, have produced jealousy and strife, militarism and war, the devastation and death of the past five years.

If any legacy of good can come of these experiences, it is that the human race shall come to realise its own solidarity beneath all its surface diversities, and in the fundamental laws of unity find the prospect of abiding peace.

(ii) In approaching the subject of what is more strictly Race-Consciousness, we find ourselves facing a much more difficult and delicate problem.

The qualities demanded in its investigation are largely ethical. They include Honesty, Candour, Tolerance, a willingness to face the whole truth. A scientist destitute of certain of these qualities discredits himself and is doomed to failure, and a deliberate determination to ignore a whole series of facts brought to his notice would be a most unscientific procedure. Yet in reference to race questions solutions are often sought with scarcely any reference to the ruling factors in the situation.

That a very real problem exists in the race-consciousness of the white and coloured peoples is evident, sometimes painfully evident, sometimes dangerously so, and nothing is to be gained by under-estimating its deep-seated nature and the gravity of its issues.

That an immediate solution of it is ready to hand, even for the most earnest seeker, no wise man will affirm. That the right road to travel is the road of Truth and Fairness every analogy of science declares.

Lest what follows should seem to be an advocacy directed to one side only, it may be stated that the difficulties in upholding the attainments and pursuing the ideals of the white race in face of an aggressive movement on the part of the coloured races are fully recognised as also well known, and not specially needing elucidation.

The neglected factors on the other side do need a 1 and temperate statement. In what the race-pro consists it is not easy to determine with exactness. fessor Royce, of Harvard, in "Race Questions and P. judices," observes:—

"Scientifically viewed, these problems of ours turn to be not so much problems caused by anything whic essential to the existence or to the nature of the race the men themselves. Our so-called race problems merely caused by our antipathies."

But these antipathies must not be belittled. They not in the category of "merely." They have ef which indicate that whatever may have been their o they have become over wide areas second nature, and so deeply-rooted that their destruction or reversal is li to be a very slow process indeed, and meanwhile involve much suffering and danger. That the prejudi in many instances artificially exaggerated and unrea ing does not lessen the peril to which society is expo That it is not altogether natural is evidenced by the that whole classes of people reared under widely separ conditions do not feel the prejudice to anything like equal extent, such as would probably have been the had both the groups been in equally close contact the opposing race. The consciousness of differenc there, perhaps innate, but only develops into activit prejudice because of the local friction between the groups. How powerful it may become, and how artifi it sometimes is, the facts reveal. An instance of may be related from personal experience. It was on occasion of a coach journey in the Transvaal ne thirty years ago, when a man, who was anxious for a seat next the coloured driver, resented the presence coloured passenger on the other side of him, though much better dressed, and in every way more present than the driver. What his motive was makes an inter ing study, but pride, prejudice, and some other kin qualities must surely have interfered with his logic. absence of intellectual honesty is even suggested.

Still, it renders no real service to underestimate diffi culties, nor need we take refuge in discussions as to relative purity of races. There is a broad band of ra purity on each side, though it is not necessary to deny existence of the varying colour blend which lies betwe

To what must we attribute the prejudice which a out of the race-consciousness of the white band? want of a better term it may be called a sense superiority, but in affirming that it may be asked whe we are quite sure that such superiority is in every insta a foregone conclusion? If such is our point of view may be asked whether we mean inherent or acqu superiority? The scientific spirit bids us ascertain point of view of other races involved. It is not unli that such investigation will reveal the fact that Chin Japanese, Indian will not readily admit the claim, w ever may be acknowledged by the cannibal aborigine. a matter of fact, the Chinese are often deeply consc of an absence of certain Eastern virtues from our Wes social system. It is at least a question open to argum in some phases, and we must not lose sight of the a mation that the infusion of Eastern and even of Afri blood in European veins is one predisposing cause of development which has resulted in our pre civilisation.

Too much is sometimes made of a phrase like the Kipling's concerning East and West. There is a s in which Occident and Orient may never meet, but w Kipling is read aright they are found capable of travel in the same direction, and the peril and difference not so great as when an unthinking philosophy m them eternally different from each other. His ha really teaches that the elementary virtues are the s the world over, and the balance is often very delicate between the claim of these and the distaste of o factors. His picture of the Brothers-in-Blood has

nterpart in brothers whose blood is unshed, which ; discovery and exploitation.

whatever may be argued, there are certainly elements white civilisation which we prefer to any other, and , because of their intrinsic worth, we do well to ; but the question of relative superiority while ng our relations with Eastern peoples in one :, to a much greater extent enters into the relations en European and Bantu or Negro peoples. The of superiority is often accompanied by a feeling of ion, and seems to be so overwhelming as to admit sort of moral control, and proceeds to ignore well-very claim which the other race may have to treat-based on fairness, while the innate consciousness of ice that, though at present debased by its history ivironment, it has the capacity to rise and develop ted as a presumptuous dream.

clashing forces are in operation, and if science may able to elaborate any system of final adjustment differences, *it does demand the recognition of the* facts of the situation, and the application of the f the case so far as they can be ascertained.

facts present themselves in various phases in nt parts of the world—(*a*) in Central Africa, where earlier stages of contact no question of social ty is presented and no democratic political rights nsidered; (*b*) in South Africa, where the social and al advancement of the native peoples is pressing fficulties forward with ever-increasing urgency; he Southern United States, where the two races, in nearly equal numbers than anywhere else, and with tical equality as a political basis, have found at t no solution satisfactory to either side; (*d*) in h South America, where we have such a near ch to a fusion of the races in certain areas as to it difficult to draw a colour line.

en the condition of the various communities is con-*l, the conclusion is easily reached that a mono-* e race and civilisation would be universally desired were possible. That cannot be, and the courses o us await consideration. These are—

The Policy of Segregation which is only partially e, and which offers no real solution if the respective ire to live in the same country. It is a theory the nefits of which can never be realised in practice as s human nature remains what it is and makes its *t demands.*

The Policy of Haphazard, if that is not a contradic-terms; the continuance of a state of flux, con-by passing impulses of feeling, personal and often nsible, and selfish interests tempered by efforts for nent, which must be continually frustrated or d in value by insincerity of application.

The Policy of Antagonism, a state of more or less onflict, in which each race seeks its own advance-*egardless of the feelings of the other,* and which ly result in a growing unrest with all the possibili-disaster, the end of which it is difficult to foresee.

The Policy of Miscegenation; a deliberate lowering al ideals to make one race, which is unthinkable, gh we are compelled to recognise that it is just here e most powerful influences are always at work in a il community to make a breach in the colour line. covery of science and no effort of the lawmaker oduced any effective barrier in the way of this the two peoples live together in the same country. e of the facts which have to be accepted, part of ice which has to be paid for the exploitation of ies which once were given over to another race, another conception of the sanctity of race can be ated by individuals for that which at present exists. ate it as we may, there are four distinct forces at break down the colour line. There is first Wealth, where the colour line is most attenuated, is a con-g factor in not a few mixed marriages. How it s is too well known to need comment. There is secondly Poverty, which brings the races together in such a way as to lead inevitably to marriage, and in which the parties most concerned are seemingly quite content to accept the conditions in which they find themselves, notwithstanding the penalties which Society often inflicts. There is thirdly Affection, the *genuineness* of which there is no reason to doubt—that uncontrollable and mighty force which ere now has brought dynasties into conflict and devastated the fairest of lands. Then, fourthly, there is the old and yet ever new manifestation of natural instinct, which, unbridled and often blind, contributes its quota to the number of those who dwell on the borderland of racial purity. To these may be added, perhaps, genius, character, some outstanding quality on the part of man or woman, on the one side or the other, which tempts to a leap over the racial barrier.

It is evident that in neither of the policies indicated can we find a permanent or satisfactory solution of our problem, or even a temporary method of treatment which *can be contemplated with equanimity.*

(*e*) There remains what Science points out as the only true method of dealing with such a question as this: the clear conception of the facts involved in race consciousness, the candid recognition of the basal right of all races and every human being to live and advance, which must be followed by such readjustments of social and political relationships as may be found desirable and practicable. It is here we find great fundamental factors neglected, *and a trailing of false scents across the line* which confuses the main issue.

The mental hysteria which has been manifested here and there in South Africa and in the Southern States of America in pogrom-like attacks on natives is at once lowering to our conception of the white race, and an intensifying of the complications already involved in our problem. We dare not contemplate the idea of turning South Africa into a permanently armed camp as between *white and coloured races, and the cost of tolerance* and helpfulness on the part of the white man towards the native may as well be faced honestly and fearlessly. Otherwise we force the matter into the hands of the agitator, whose opportunities will increase and not lessen as the years pass, unless the nation is aroused to its responsibilities.

Accepting the present superiority of the white race and its civilisation, we cannot escape the obligations and *responsibilities of that superiority.* Though *scientific* experiment and theory may not directly concern character, yet we cannot, in adopting a method which asks for all the facts, explain race consciousness and either justify or condemn its expression, or attempt to improve its outward relations without recognising the ethical element.

Starting on the lower ground, science allots to objects and organisms the functions of which they are capable, and in utilising them, suggests the aid needed in performing such functional operations to the best advantage.

The coloured races are no longer in the dark concerning their own potentialities, and the social, economic, and political rights which are enshrined therein. Chinese, Japanese, and Indian on the higher platform, and African on the lower, are advancing with strides, which in some instances are assuming gigantic proportions, and, as one has tersely put it, "The race must come to terms with the races."

We cannot, if the dictates of science are to be obeyed, place the native life, with which we are in contact, and our treatment of it, on a lower plane than that of our growing crops and domestic animals, yet that is precisely what those are doing who reject all attempts at education, social advancement, and any other *effort* towards the betterment of conditions, save such as subserve the purpose of producing a labourer at the minimum of cost, and with the least possibility of making him a competitor in any other department of life.

It is essential that due regard be paid to the race-consciousness of a people who recognise a sense of lack in

their present degraded condition, who feel the need of education to supply what is wanting, and who are moved by a desire, increased by a knowledge of what some have already accomplished, to attain to a higher standard of life and service in the community. That everything which is desired cannot be granted or attained all at once is no reason whatever why all that can be done should not be done. Civilisation in a hurry would necessarily produce pernicious results, but to block it almost completely by unfair and unreasonable repression is to sit on the safety-valve, and the community which does that of set purpose, or even through carelessness, must accept the consequences. Citizenship cannot in these days be permanently withheld from any section of the community which shows its fitness for it without endangering the peace and safety of the body politic.

The duty before us seems to lie in this direction—

(*a*) To conserve the universal interests, as far as may be, which the consciousness of both races conceives to be of permanent value.

(*b*) To supply the lack which either expression of race-consciousness fails to recognise, which can only be done by a process of mutual education through intellectual intercourse.

(*c*) To so advance the interests of the community as a whole that security and progress for the future shall be ensured.

In regard to these propositions it is a commonplace of all race intercourse that the relationships must be characterised by justice, not only in matters pertaining to law and its administration, but in due consideration for each other's point of view, in opportunity for advance freely granted, and in the provision of such means as are essential thereto. Our native people must learn that claims and aims must be clearly and temperately advanced, and that the value of character behind them is of prime importance. They should be encouraged in this direction by due recognition of the nature and spirit of such efforts for advancement, as against the engineering of crises which call for the use of force and delay progress. They must have clearly revealed to them the sources from which our greatness has been derived and taught the value of them.

In this respect no little assistance is afforded by a grasp of the mutuality of the interests involved. This is evident, sometimes distressingly so, in such a matter as Health. A Southern Officer of Health affirms of the negro: "If he is tainted with disease you will suffer." What is true of physical health is equally so in regard to Morality the same officer affirms in adding: "If the negro develops criminal tendencies you will be affected." The nation as a whole loses by every physical degenerate which it produces, and by every criminal which it helps to create, and national efficiency has its standard lowered throughout in proportion to the extent to which its individuals do work inferior in quantity and quality to that of which they are capable.

Herbert Spencer's dictum is worth pondering in this relationship: "No one can be perfectly free till all are free; no one can be perfectly moral till all are moral; no one can be perfectly happy till all are happy."

A system of life which persistently ignores the claim and potentiality of the moral consciousness in the working out of these problems is self-condemned. "Any system of ethics must aim to develop character; it must establish a standard of good and evil; it must judge actions according to this standard and provide an inner check, which will restrain the will of the individual," is a sentiment recently uttered, which has its application here. Shelley sings of

> . . . . man
> Equal, unclassed, tribeless, and nationless,

but that can scarcely be in this everyday world. We have our race-consciousness, our differences of temperament and even of ideal, but we need not exaggerate these. Carlyle once drew a cynical distinction betw the respective attitudes of the North and South of United States towards the black population in the fo ing way:

> The South said to the black, "You are slaves, bless you!"
>
> The North said to the black, "You are free, God d you!"

We need not follow either example. This we recognise, however: every race has a right to existe every race has a right to the best of which it is capab becoming; every man has the responsibility of hindering other races in their struggle for the best; e race which seeks the highest for itself will be foremos helping other races to attain their best, for only in so d can they reach their own highest.

Race growth must be slow, but there is no reason it should not be real growth. To put the practical is there are four directions in which native aspiratio revealing itself which seem not unreasonable—

(*a*) Fair wages according to the nature of the v done, and the right to the necessities of advancing so life.

(*b*) Better housing, with special reference to t residents.

(*c*) Educational facilities.

(*d*) Political representation.

With increasing capacity for better classes of work be wages must inevitably come. The housing of native and on the outskirts of our towns is a disgrace for wh terms of condemnation can scarcely be too strong. Fa ties for better and wider education in letters, in agri ture, and industry, are being granted, but there is m leeway to make up. And the devising of an adequate progressive system of political representation should be beyond the power of a community like ours.

Referring to the larger aspects of race differe Sir Douglas Haig has recently observed:

"These and other problems which must, unsolved, rise to mighty wars are capable of solution by giving all races, however insignificant, what we proudly reg as British freedom and justice, and thereby, in the co of many years, levelling them up to our own standard.

Perhaps the first practical difficulty in developing th aspirations arising out of native consciousness is financial one. Money! Yes, it will cost money. S does to keep out East Coast fever; but Science sa "Dip!" and the money has to be found. It costs mo to get better crops; but Science says, "Phosphates," they have to be obtained from somewhere. It c money to improve the industrial output; but Science s the old machinery is wasted power, and Economics co along and scraps it. Is it necessary to point out analogy? Vested interests say, "It will cost us m in the way of social prestige, return for our labour, and the profits on our capital;" but Science declares by ev analogy of natural law, and by each disclosure of exp ment, that if the Best will not improve the Worst, t the Worst will drag down the Best. Social questi which involve money do not, after all, take long to ri themselves by natural processes of readjustment.

Sir William Ramsay, whose word should not be with weight in these circles, observes that, "The test civilisation is prevision; care to look forward, to prov for to-morrow; the morrow of the race as well as morrow of the individual; and he who looks furth ahead is best able to cope with Nature and to conq her."

Our Geography defies our puny efforts to destroy it; are here together for better or for worse. Our Hist refuses to be blotted out; we came here and must fa the responsibilities of being here. Our Science disclo the inexorableness of Nature's laws and bids us o them. Our Consciousness as men, built on the solida

e, though manifested in great diversity, bids us our higher instincts; be faithful to the best in *join hands for the destruction of the worst in* ; and aid the rise of all who seek to climb the eights.

## RE EXPERIMENT UPON COMBUSTION.

By A. PRICE, B.Sc. (Lond.).

arranging experiments to illustrate "gas caps," ar phenomena, for lecturing to classes of mining I devised a simple arrangement, which I have described elsewhere. It is very effective, but it the absence of draughts of air in the neighbour-d a darkened room, as the phenomenon can only *in daylight by those close to it.*

nsen burner is made from a long wide glass tube rated in Fig. 1, and a little above the top of the vire is clamped at right angles to it. The gas is rned on, so that *a mixture of coal-gas and air* the tube as in the ordinary Bunsen burner. By carefully lowering a small flame on to the wire, with possibly a little adjustment of the gas supply, the gas can be made *to burn off the top of the wire, and to keep on* burning indefinitely with a very pale blue luminosity, the form of which is represented in Fig. 1, and, in a direction at right angles to it, in Fig. 2. A useful modification can be made by hanging a small *rounded object*, such as a little bullet, by means of a fine wire as shown in Fig. 3, when the luminosity takes the form illustrated.

The phenomenon is of the nature of a "gas cap," which the *miner gets in testing for fire-damp by means of a safety* lamp; but it has the advantage that it is not kept up by any source of heat, as occurs when using the miner's lamp. The gas is apparently burning below its actual "ignition-*point," and the experiment illustrates combustion below* this particular temperature, of which a good *résumé* can be found in Prof. Smithell's Address to Section B of the British Association in 1907. That the temperature is high *is shown by the wire in Fig. 3 becoming red hot.* The continuance of the phenomenon depends upon the mixed gases coming up the tube at a certain velocity, for by carefully cutting off the gas, so as to reduce the velocity, the *phosphorescing gas can be made to leave the wire, and to* "strike back" down the tube to the gas jet at the bottom

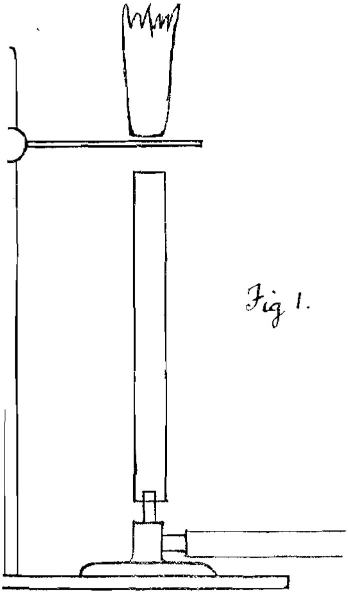

Fig 1.

Fig 2

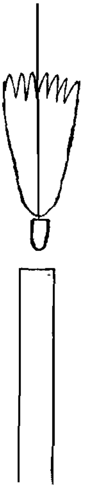

Fig 3

The presence of the wire or the little bullet lowers the velocity of the mixed gases, and so enables the gas to burn, but the combustion cannot be transmitted to the uprising gas as its velocity is greater than the rate of propagation of burning. Here again the experiment can be utilised for explaining the action of the Bunsen burner, and that the ignition cannot be propagated against the uprising current of mixed gases if the velocity of this be too great.

Chemical Laboratory,
Technical School, Barnsley.

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## NICOTINE AND TOBACCO SMOKING.

By NEHEMIAH ASHERSON.

EXPERIMENTS were undertaken with a view to determining to what extent the nicotine in a cigarette is destroyed in the smoking and thus find out how much is inhaled, and to test for the alkaloid in the fumes. Text-books are obscure on the point.

The method of procedure adopted was to set up an "automatic" smoker and estimate the nicotine in the inhalation and smoke. The diagram shows the apparatus. A is a large glass jar of about 4 litres capacity, and has two openings. To the upper one is attached a tube loosely packed with plugs of cotton-wool. This filter will effectively retain any liquid constituent of the smoke drawn through it. It is in connection with an aspirator (the filter-pump in this case), and thus the air in the jar will be constantly filtered through this tube; B is a similar tube, but very much longer. It contains a glass cigarette holder fixed to one end, while the other end is in connection with an aspirator capable of drawing a slow regulated current of air through a cigarette in the holder. Care must be taken that the tube is long enough and that the inhalation is deprived of all its nicotine.

The ignited cigarette is inserted into the flask and its rate of combustion regulated by the aspirator of the water flow type. The ordinary puff and rest of the smoker is imitated. All but half an inch of the cigarette was consumed.

The nicotine contents of the tobacco was determined by Pinette's method and calculated on the dry basis, the percentage of water being first found. An average of 15 per cent was found for the water content.

The dried weighed tobacco, after crushing, is extracted with ether in Soxhlet for two hours—some alcoholic caustic soda being added initially to liberate the alkaloid from its combination with organic acids.

The ethereal extract is evaporated to dryness and steam distilled—500 cc. being collected. This distillate is titrated —100 cc. at a time—with N/20 $H_2SO_4$. The best indicator appears to be rosolic acid, although this indicator is not the one popularly recommended in books.

One cc. N/20 $H_2SO_4$ corresponds to 0·0081 grm. nicotine. To estimate the nicotine in the inhalation, the cotton-wool in the smoking-tube is steam distilled after the addition of caustic soda and the distillate titrated as above.

The average nicotine content of the cigarettes was 20 mgrms. About forty cigarettes were taken, in which the water and nicotine content were known from the analysis of an aliquot portion. These were weighed and smoked in the apparatus. The ends were collected and weighed, and thus the weight actually smoked was known. *About two-thirds of a cigarette is normally smoked*; *e.g.*, in the first series of experiments the total weight was 29·7 grms., the ends yielding 9 grms.; in the second series these figures were 26·5 and 9 grms. respectively.

The amount of nicotine in the inhalations was then determined. Knowing the amount in the burnt portions the amount destroyed can be estimated (Table I.).

(NOTE.—The weight of the burnt cigarettes being known the nicotine in the inhalation is referred to this weight and given as a percentage).

The first series (A) of experiments was with th called "Flag"—a universally smoked cigarette i Africa; the second series (B) on a more exper widely smoked brand also. The average weigh former was 1 grm. per cigarette; in the lat 1·3 grm.

TABLE I.

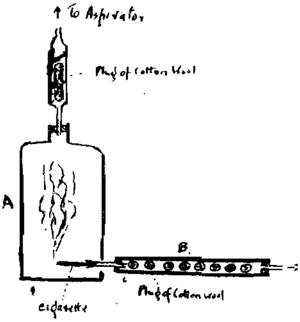
| | A. |
|---|---|
| Weight of cigarettes (grms.) .. .. | 29·7 |
| Weight of ends (grms.) .. .. .. | 9 |
| Per cent nicotine .. .. .. .. .. | 2 |
| Per cent nicotine based on inhalation | 0·94 |

TABLE II.—*Analysis of "Ends."*

| | "End." | "O |
|---|---|---|
| Weight per cigarette (grms.) .. | 0 3 | |
| Water (per cent).. .. .. .. | 21 2 | |
| Nicotine (per cent) .. .. .. | 3·2 | |

Thus these experiments lead to the conclusion more than half the nicotine is destroyed in the com and that the remainder (neglecting, of course, th amount that condenses in the cigarette end) en system. The second series of experiments would indicate that the smaller the percentage of nico less is the amount destroyed.

Put in figures this means that the average c contains 19 *mgrms. nicotine*; *in the portion*




smoked, about 14 mgrms., of this about 7 mgrms the mouth. (According to Blyth in his book on "Po the fatal dose is about 6 mgrms. of the pure al Blyth has also on record several interesting ca nicotine poisoning through smoking.

In South Africa, farmers—who are great pipe sm often kill snakes by means of the "pipe oil" accumulates in the pipe. It contains a high percen nicotine (estimated at 40 per cent), and has rapid results when taken by the snake.

In the smoke of thirty cigarettes only a trace of n *was found.*

A summary of the results are given in Tab Analysis of the cigarette ends yielded the expected viz., a slightly higher nicotine and water content.

Tobacco-ash from cigarettes has a greyish black due to the presence of particles of free carbon as a of incomplete combustion, *which would also acco* the fact that all the nicotine is not destroyed. The a amount of carbon in ash was about 10 to 15 per cen

A determination of the amount of carbon in the

ficially smoked cigarette yielded a similar figure, is used as a check as to the combustion in the tus, being the same as would be if the cigarettes noked naturally.

TABLE III.—*Summary*.

| | A, "Flag." | B, "Loyalist." |
|---|---|---|
| t of cigarette (grms.) .. | 1 | 1·3 |
| (per cent).. .. .. .. | 15 | 9 5 |
| r cent) .. .. .. .. | 15 6 | 15 7 |
| e (per cent) (*a*) .. .. | 2 2 | 1·5 |
| t per cigarette (mgrms.).. | 19 | 18 |
| t inhaled per cigarette ms.) .. .. .. .. .. | 6 | 8 |
| t of cigarette end (grms.) | 3 | 44 |

(*a*) *On dry basis.*

amount of carbon is determined by gentle incinera- d noting the loss of weight; the temperature must too high, otherwise the carbonates in the ash be destroyed and thus give a high result.

her fact to be noted is that the ash of a cigarette utes 15 per cent of the total weight. It is well the tobacco crops exhaust the soil of inorganic nents rapidly.

above work was carried out in the chemical depart- of the University of Cape Town, and the writer lot to Prof. H. Tietz, M.A., Ph.D., for suggestion lp as well as materials.

## HE NON-FERROUS METAL TRADES.

### THE IMPORTANCE OF INDUSTRIAL RESEARCH.

ritish Non-Ferrous Metals Research Association has shed its headquarters in Birmingham (at 30, Paradise . *It will take the form of a limited liability* ny working without profit and with a nominal itee from members in place of shares.

province of the Association includes all the non-ferrous industries throughout the country, including copper, zinc, aluminium, gold, silver, and other alloys, and ects are defined as "to arrange for the carrying out ntific and industrial research and the dissemination ; its members of technical and other information g to the production, treatment, manufacture, and f non-ferrous metals." All British firms engaged in ranch of the non-ferrous metal industry, whether ers, manufacturers, or users, are invited to join sociation, and thus to become eligible for benefits ng from its scientific investigation. Non-British re excluded from membership. The members will an annual subscription based upon the capital em- l in the business. The scale of assessment is as s:—Minimum annual subscription, £25; maximum l subscription, £200 (for the first year). Subscrip- for firms wholly engaged in the non-ferrous metal ry are:—On the first £20,000 capital, 3s. per cent; next £20,000 capital, 1s. per cent; on all over 0, 6d. per cent. Subject to certain conditions, *e.g.*, search is conducted on a sufficiently large scale, for £1 expended annually on research and the Informa- ureau, a grant of £1 (up to £5000) will be made lly over the agreed period from the Government of a million sterling placed at the disposal of the tment of Scientific and Industrial Research.

advantages to be derived from membership are as s:—(1) The right to receive from the Information n scientific and technical information; (2) the right mmend for the consideration of the Council specific ts for research and enquiry; (3) the right to ask the il for a specific research or enquiry to be undertaken for their sole benefit, or for the sole benefit of a particular group of members, at a cost price, but the Council shall not be bound to grant such request, and may, in granting it, impose any conditions or restrictions they think fit; (4) subject to certain limitations the right to benefit by all results of the work undertaken by and carried on for the Association or any part of same; (5) the right to the use of any patents or secret processes resulting from all re- searches undertaken, either without payment for licenses or at only nominal payment compared with firms outside the organisation. It is intended at an early date to obtain suitable quarters for housing an Information Bureau at Birmingham, to appoint a staff, and later to establish branches in various centres of the country. A librarian has been appointed, and a beginning has been made in the filing and indexing of material, and every effort will be made to develop the Bureau as quickly as possible so as to meet the requirements of members as far as possible within the scope of the Association and its allied institu- tions. The Association will not carry out routine investi- gation such as should be done in a works laboratory, and it is hoped that the system of research departments which have proved so valuable in the ferrous metals trades will be more generally adopted by firms in the non-ferrous metals industry.

In the near future a programme of research will be drawn up, primary attention being given to the more urgent needs of the industry. At the outset, at any rate, the Association will not set up its own laboratory, but will work through the laboratories of existing institutions, such as the universities. Arrangements have already been made for the Association to take over the work and equipment of the Brass and Copper Castings Research Committee, which, under the direction of Prof. Turner, has for the past two years been investigating the production of sound ingots. Power has been taken to encourage the training of expert research workers, and to improve the technical education of persons engaged or likely to be engaged in non-ferrous metals industry.

The following gentlemen have promised to assist the Research Association in an advisory capacity:—Mr. W. R. Barclay, Prof. H. C. H. Carpenter, Prof. C. H. Desch, Prof. C. A. Edwards, Dr. W. Rosenhain, Mr. A. E. Seaton, and Prof. T. Turner.

## NEW METHOD OF DEHYDRATING FOOD.

MEATS, eggs, vegetables, and fruits can now be dried in a manner which preserves their original properties and nutri- tive value and still have an appearance of freshness when prepared for the table. Although in former years there were dried fruits and vegetables that had a fine appear- ance, it was often found that they had been treated with sulphites and other materials, the use of which had been questioned by food experts.

Dr. K. George Falk, of the Harriman Research Labora- tory, Roosevelt Hospital, New York, explained the new methods in an Address before the New York Section of the American Chemical Society, of which he is a member. He announced that, following the experimental stage in this process, meats and vegetables had been thoroughly dried in the Industrial Chemistry Laboratory of Columbia University under the supervision of Prof. Ralph H. McKee, and had been shipped to different parts of the world, where they have been used with success. One consignment of the meat dried in this manner gave great satisfaction in Armenia, where it was distributed by the Near East Relief Fund. Other products of the new dehydration process had been taken to distant parts of the world by exploring parties and had been found to answer all the requirements.

Dr. Falk said that from these meats and other foods which were dried in a vacuum delicious dishes could be made, the taste of which would commend them to any

housewife. From the dried meat, savory stews and hashes are made, while the vegetables which may be incorporated with the meat have as fine a flavour as if they had only recently come from the garden.

It would be possible by means of this process to dry beef in vacuum ovens in parts of the earth where cattle may be raised very cheaply, as in Argentina, and to transport the dried product for many thousands of miles at very low freight cost. As canned fruits contain considerable moisture and are placed in metal containers, the advantages of the vacuum-dried products become manifest, according to the view of Dr. Falk.

"Transportation," said he, "has always been a question of vital importance. Ships and other common carriers are always at a premium, and again certain kinds of food require special equipment, such as cold storage. For example, the plentiful supply of sheep in New Zealand might benefit the rest of the world to a greater extent if more transportation facilities were available."

Dr. Falk said that usually sun-dried meats and other foods were discoloured and that their nutritive values were impaired. While even with fairly good methods of dehydration it would have been found necessary to use bleaching agents, a recourse which was not required, according to the process developed at the Harriman laboratories. The incentive to develop this method of preservation for food products was given early in Nov., 1917, by Col. John R. Murlin, in charge of the Division of Food and Nutrition of the U.S. Army, and was developed by Dr. Falk, Dr. Edward M. Frankel, and Prof. Ralph H. McKee.

"In the dehydration of meats," said Dr. Falk, "the temperature must be kept below the point at which the proteins coagulate, for if there is too low a temperature the process of dehydration will be unnecessarily prolonged, with the result that often spoilage will occur and the overhead cost will be greatly increased. It is possible to solve this problem of dehydration by the use of a suitable vacuum drier in which the meat or other food product is introduced, in pieces of suitable size, and kept in the vacuum at a temperature which is below that of cooking or which makes no appreciable change."

Dr. Falk said that a large variety of foods had been dehydrated by the vacuum method and that a number of others will probably be subjected in time to the same process. The mechanism used is not complicated and can be easily installed at remote places.

"In considering food preservation methods in general, it may be stated," he said, "that such methods will come into use more and more." The Government estimated that 50 per cent of the fruits and vegetables grown in this country never reach the consumer as a result of poor transportation facilities, irregularities in marketing, or other causes. At the same time, greatly because of recent work on such questions as food hormones, the tendency is to use fresh foods wherever possible. The newer dehydration processes approach more nearly the requisite standards of fresh foods than do the older methods of preservation. The whole question is in a state of development. Dehydration offers the most promising outlook for the future. Air dehydration marks a great advance over the older methods of food preservation, and it would appear that vacuum dehydration possesses in its turn advantages over air dehydration—(*Am. Chem. Soc. News Service*, No. 249). —*Journal of the Franklin Institute*, January, 1920.

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German Potash for America.—It is understood that the negotiations for the sale of large quantities of potash to America, which are being conducted by the Potash Syndicate, are nearing conclusion. The deal has still to be approved by the General Directorate of the Potash Syndicate, which is holding a meeting within the next few days. The *Vossische Zeitung* says that the quantities involved will cover half of America's total requirements.—*Reuter's Trade Service.*

# PROCEEDINGS OF SOCIETIES

## ROYAL SOCIETY.

*Ordinary Meeting, February 26, 1920.*

Sir J. J. Thomson, O.M., President, in the Ch

The following papers were read:—

"*Some Measurements of Atmospheric Turbulence* L. F. Richardson.

The eddy-shearing stress on the ground is deduce pilot balloon observations. Values on land in ar sistent dynamical units are found to range from o·( 0·007 times the value of $\overline{m}^2/\rho$ where $\overline{m}$ is the momentum per volume up to a height of 2 km. ar the density.

Evidence is given to show that the eddy viscosity the wind at Lindenberg increases with height, and, near the ground, is much greater than the eddy vi along the wind.

In Parts IV. and V. the spreading of a lamina of is considered.

Osborne Reynolds' eddy stresses are studied. F occasion an attempt was made to measure simultar all six components of stress, by observing the mot thistledown. The three direct stresses are easily mea Not so the shearing stresses; however, one was fo he 2·4 times its probable error.

The theory of scattering of particles summarise numerical values derived from scattering.

The "turbulivity" $\xi$ is estimated from the rising in calm weather and found to be $10^6$, applicable c the sense of friction. Thus the whole range of $\xi$ ob in the free atmosphere was from seven to a mill contrast with 0·2 in perfectly still air. The eddie s observed have ranged in absolute value from 0·004 dynes $cm^{-2}$.

"*On the Viscosities and Compressibilities of Liqu High Pressure.*" By J. H. Hyde.

In the first place experiments were made to dete the change in the value of the kinematical viscosit of the various oils, and after this investigatio completed apparatus was designed for the dete tion of the change in density with pressure. apparatus used for the determination of the kinem viscosity consisted essentially of a system of two zontal (the upper one of capillary dimensions) ar vertical tubes forming a closed circuit of liquor pressure, the lower half of the circuit containing m and the upper half the liquid under test. One end tubular frame rests on a horizontal knife edge, a frame is supported in a horizontal position by a spring. On the mercury being displaced by a amount, flow will take place round the circuit owing difference of head, and it is evident that if the spr so designed that its range of extension is equal to th of change of head of the mercury, flow of the under test will take place through the capillary tube a constant pressure-difference and at a velocity whi be calculated from the rate of extension of the sprin this way all the data required for the determination absolute kinematic viscosity of the fluid were deterr

The determinations of the variation in density pressure were made by measuring the decrease in v of known quantity of the liquid enclosed in a cylinder sealed at one end and closed at the othe long steel plunger. The cylinder and plunger enclosed in a pressure vessel, and the motion c plunger for any particular pressure was measured. density was calculated from the decrease in the v thus measured.

From the values of the density ($\rho$) and those kinematical viscosity ($\eta/\rho$) obtained for the oils, the

absolute viscosity ($\eta$) were calculated. The results that the absolute viscosity of all the oils tested in- es considerably with pressure.

"*he Capacity Coefficients of Spherical Conductors.*" . RUSSELL.

is proved that the capacity coefficient of a spherical ctor equals its radius, together with the capacity of ondenser formed by the spherical surface on the one nd the images in it of all external objects connected allel on the other side. This theorem leads at once lations between the capacity coefficients of a system o spheres and the capacities of certain spherical con- rs which lessens very appreciably the labour involved mputing the values of these coefficients which are ed in practical work. The mutual coefficient also is in terms of the capacity of a spherical condenser, and relations between the various capacities used by eers and physicists are proved. Finally, a method of g the approximate value of the capacity between a e and distant large conductors is given.

"*n the Refraction and Dispersion of Carbon Dioxide, n Monoxide, and Methane.*" By C. CUTHBERTSON, S., and MAUDE CUTHBERTSON.

e refractivity of the above-named gases have been red at eight points in the visible spectrum between 8–4800.

e work was undertaken with the object of ascertaining efractive power of the carbon atom, on the assump- f the validity of the additive law. By deducting the tiv ty of the oxygen or hydrogen atoms from that of rbon compound values are obtained from which the tivity of carbon can be expressed in the form—

$$\mu - 1 = \frac{C}{n_0^2 - n^2}.$$

r $n = 0$ the expressions obtained are:

| From carbon dioxide | Carbon monoxide. |
|---|---|
| $\frac{2\cdot7705}{16042} = 0\cdot000173$ | $\frac{1\cdot988}{10213} = 0\cdot000195$ |

Methane.

$$\frac{1\cdot672}{10623} = 0\cdot000157$$

ere are thus wide differences, not only between the nts, which give the refractivity, but between the rators, which should be proportionaal to the number dispersion electrons," and the denominators, which he squares of the hypothetical free frequencies. The affords a further proof that the "additive law" is stworthy except as a rough guide.

"*he Phenomena of Rupture and Flow in Solids.*" By GRIFFITH.

iculties which had been experienced in predicting the re of machine parts under certain types of loading sted the desirability of a fundamental inquiry into the anism of rupture. A theoretical criterion of the e of an elastic solid, based on the "theorem of num energy," is enunciated in the paper. This has shown experimentally to be true in the case of a glass which contains a crack when unstrained. The cal- on involves the surface tension of the material. In the ments the maximum stress in the glass was estimated more than ten times the normal tenacity of the material. hown that this result is incompatible with the general on of rupture unless the material is weakened by dis- nuities of flaws whose dimensions are at least of the ten thousand times the molecular spacing. Evidence uced to show that the strength of other substances, ing metals and liquids, is governed by similar con- tions, and that an enormous increase in the tenacity terials would be possible if the flaws could be ated. Experiments are described showing how the ation may be performed in the case of glass and fused silica, it having been found possible to prepare samples of these materials with nearly fifty times their normal tenacity. The strong phase of these materials is, however, unstable, and changes spontaneously in a few hours to the normal modification.

It is shown that many of the phenomena associated with the mechanical properties of materials, including those described in the present paper, are capable of explanation in general terms if it be supposed that intermolecular attraction is a function of the relative orientation of the attracting molecules. Some consequences of this theory are discussed in the paper.

The paper concludes with a short discussion of the bearing of the work on engineering practice.

## THE INSTITUTE OF METALS.

*Annual General Meeting, March 11, 1920.*

THE following is a summary of the Fifth Report to the Corrosion Committee, presented by Guy D. Bengough, M.A., D.Sc., R. M. Jones, M.Sc., and Ruth Pirret, D.Sc.

"*The Action on Aluminium of Hard Industrial Waters.*" By RICHARD SELIGMAN, PH.Nat.D., Member, and PERCY WILLIAMS, B.Sc., Member (London).

The authors first describe in detail the various forms of corrosion which aluminium exposed to the attack of hard industrial waters undergoes, and differentiate between superficial attack or "etching" and localised deep attack or "pitting." They point out that while etching is of no practical importance, pitting is one of the greatest diffi- culties the aluminium industry has to contend with. They discuss the various hypotheses extant by which the in- ception of corrosion is sought to be explained and show that these all entail the presence of oxygen. Experi- ments are described which show that in the absence of oxygen neither pitting nor etching occur even with sea- water. Other factors which might determine whether "etching" or "pitting" occurs are cited and discussed. These are "The Presence of Impurities," "Local Physical Differences in the Metal," "The Composition of the Water," and Mechanical Imperfections in the Metal." The authors conclude that the composition of the water and mechanical imperfections in the metal are responsible for pitting, which only occurs when the water c ntains simultaneously chlorides and bicarbonates. The roll of mechanical imperfections is to facilitate the retention of hydrogen peroxide which is produced during corrosion and which in its turn promotes corrosion. In the second part of the paper a number of methods for preventing cor- rosion of aluminium by hard industrial waters are dis- cussed. A bibliography of papers dealing with the subject is appended.

"*The Art of Casting in High Tensile Brass.*" By NEIL J. MACLEAN (Glasgow).

"Manganese Bronze" castings as supplied by different makers having proved unreliable and unsatisfactory, a series of experiments was carried out with a view to obtain- ing castings made in sand moulds (unchilled) having a guaranteed strength of not less than 20 tons per square inch, as shown by test bars produced under the same con- ditions as the castings themselves. As a result of these experiments a copper zinc alloy was chosen containing 3 per cent of nickel and 2 per cent of iron, with a small quantity of manganese and phosphor tin. Special pre- cautions were taken to accurately weigh the charge and to control the pouring temperature within narrow limits. A hardener of copper-nickel-iron was made up and finely granulated by blowing the molten metal into a tank of water. Special attention was paid to keeping the zinc content constant; ingots were analysed after first melting and the zinc corrected when making up the final charge. The alloy finally decided upon was made up of scrap, new metal, and hardener, with the addition of zinc to correct

for loss in previous melting. By this accurate weighing of the charge, control of pouring temperature, correction of zinc, and use of special hardener, castings were obtained having strength properties 50 per cent better than gun-metal and at a cheaper price.

"*The Removal of Internal Stress in 70 : 30 Brass by Low Temperature Annealing.*" By H. Moore, O.B.E., B.Sc., F.I.C., and S. Beckinsale, B.Sc., A.I.C. (London).

The authors have carried out a series of experiments to determine the temperature range within which internal stress may be removed from cold worked 70 : 30 brass without serious reduction of hardness. Cups spun from sheet and initially in a state of high internal stress were annealed at temperatures ranging from 200° to 325° C. for periods of one minute to 120 hours; they were then treated with mercurous nitrate solution which causes stressed brass to crack. Samples of cold-rolled strip of Brinell hardness 90, 120, 165, and 200 were annealed together with the spun cups. The hardness of the strips was determined before and after annealing. Internal stress was removed from spun cups in five hours at 250° C., one hour at 275° C., twenty minutes at 300° C., or five minutes at 325° C. Strip of initial hardness of 200 was appreciably softened by each of these treatments, but the hardnesses not exceeding 120 were not reduced at temperatures up to 300° C. Strips of initial hardness of 165 began to soften slightly in two hours at 275° C., or twenty minutes at 300° C. The hardness of fully annealed 70 : 30 brass is about 50 to 60, and a hardness exceeding 165 is rarely if ever required in cold-worked brass. The first effect of low-temperature annealing is a distinct though small increase in hardness.

"*Zinc Alloys with Aluminium and Copper.*" By W. Rosenhain, D.Sc., F.R.S., John L. Haughton, M.Sc., and Kathleen Bingham, B.Sc.

The constitution and mechanical properties of alloys of zinc containing copper up to 10 per cent and aluminium up to 15 per cent are described in this paper. The constitution may be briefly summarised by saying that there is a ternary eutectic containing 4 per cent of copper and 7 per cent of aluminium, and two binary complexes, one the depressed eutectic of the aluminium zinc alloys, and the other formed from one constituent of the aluminium zinc and one of the copper zinc series. The ternary eutectic does not extend much beyond the alloys investigated. The rolling properties of the alloys have been studied, and it has been found that the addition of 1 per cent of copper improved both the hot and the cold rolling properties of zinc to a very marked extent. With the addition of more copper or aluminium, the cold rolling properties fall off rapidly. All the alloys are capable of hot rolling, but those containing much copper and aluminium become very brittle on cooling. The mechanical properties of the alloys are somewhat complex. The rolled material has, in many cases, a very high elongation if tested soon after being rolled, but in the course of a few months this falls to quite a low value; in one case from 70 per cent on two inches shortly after rolling to 1 per cent after one year. Annealing at a temperature as low as 100° C. has a similar effect, although heat treatment has no influence on cast specimens. The rate of loading in the tensile test has also a very marked effect; with rapid loading the maximum stress is very high and the elongation very low, whereas under very slow loading this is reversed. These observations can be explained on the assumption of the existence in the alloy of a considerable amount of amorphous material, produced by rolling. Other experiments confirming this hypothesis are described. For castings of such a nature that the small shrinkage, which occurs on ageing in most of the cast alloys, would not be deleterious, an alloy containing 3 per cent of copper and 6 per cent to 15 per cent of aluminium is recommended. For rolled material, zinc containing 1 per cent of copper appears to be very promising.

"*A Model for Representing the Constitution of T[ernary] Alloys.*" By W. Rosenhain, D.Sc., F.R.S., Vic[e-President] (Teddington).

The paper describes a form of model by means o[f] the thermal-equilibria of a system of alloys con[taining] three metals can be represented. The use of mod[els for] this purpose is well known, but the majority of [those] hitherto constructed have consisted of solid pie[ces or] blocks, shaped in accordance with the data obtai[ned by] observation, and fitted together to form a complete [model]. With this form of construction, however, a compreh[ensive] view of all the various surfaces and boundaries can[not be] obtained, since the inner surfaces cannot be seen th[rough] the bulk of the solid model. In the model descri[bed in] the present paper no solid blocks are used, but a co[nstruc]tion of wires is adopted. The lines, curved or st[raight,] along which the various equilibrium surfaces m[eet one] another are first set out by means of relatively stout [wires.] The surfaces themselves are then indicated by a ne[twork] of finer wires, which, while indicating the shap[e and] position of each surface, yet allow all the other su[rfaces] both below and above, to be seen at the same time. [Dis]tinction between the various surfaces is facilitated [by the] use of colour, each colour used being correlated to [one of] the phases which occur in the alloys. A model thu[s con]structed allows of a comprehensive view of the wh[ole of] the equilibrium conditions and affords an insight in[to the] constitution and behaviour of the alloys, which is [not] readily obtained in any other way. The paper is [illus]trated by means of photographs, diagrams, and d[escrip]tions of a model representing an ideal ternary syst[em of] alloys, in which various typical features are represen[ted.]

"*Tin-phosphorus Alloys.*" By A. C. Vivian, A.R.S.M., Member (London).

Investigation of alloys obtained by the use of pre[ssure] tubes, examination of constitution, isolation of phos[phides] found, and suggested temperature-concentration dia[gram] up to 40 per cent or 50 per cent phosphorus con[tent]. (Work at Cambridge under Mr. C. T. Heycock, F.[R.S.]) Ordinary phosphor-tin up to about 8 per cent phosp[horus] is prepared at atmospheric pressure. Under pressu[re in] sealed vacuous hard glass tubes the alloys were ma[de by] putting the elements together in increasing proportio[ns of] phosphorus and heating slowly to 700° C., then co[oling] very slowly. Upon macroscopic and microscopic e[xami]nation of the series the following points were broug[ht to] light. Phosphorus and phosphides insoluble in soli[d tin.] Atmospheric pressure alloys (up to about 8 per [cent] phosphorus) consist of solid solution ($a_1$) of tin, in t[he] phosphide $Sn_4P_3$ (16·4 per cent), in a ground mass o[f] tin—(maximum solid solution 14·7 per cent). Pre[ssure] tube alloys—conjugate solutions appear (6 per cent [to] 20 per cent). Cooling conditions of perfect equili[brium] between the conjugate solutions existing in this [range] would give (for average concentrations below 16·[4 per] cent) $a$, in a tin ground mass $a_2$, in $a\beta$ eutectic wou[ld be] found with concentrations above 16·4 per cent. Wi[thout] stirring or seeding the freezing of these conjugate [solu]tions exhibits a somewhat complicated series of ha[lt]ings which are examined at some length with the a[id of] cooling curves taken from the alloys in the sealed [tubes] in an origininal manner. Above 20 per cent $\beta$ crysta[llises] from $a\beta$ eutectic up to $\beta$ composition 25·8 per [cent] $Sn_3P_4$. Above this, $\beta$ crystallises from $\beta\gamma$ eut[ectic] ($\gamma = SnP_3$ 44 per cent P.). 31 per cent is $\beta\gamma$ eut[ectic]. Above $\beta\gamma$ eutectic another range of conjugate solu[tions] occurs in the series of which the lower solution [is] eutectic and the higher appears when solid to consi[st of] $SnP_3$ and fibrous red phosphorus very closely interw[oven]. All the phosphides have been isolated chemicall[y and] mechanically.

"*Some Notes on the Effect of Hydrogen on Copper.*" W. C. Hothersall, M.Sc.Tech., and E. L. Rh[odes], M.Sc.Tech., Member (Manchester).

That copper in common with other metals is capab[le]

ing various gases has been common knowledge for years, and some attention has been paid to the in regard to both the metal and its alloys. , however, notice has been directed to the effects ssolving gases have on the soundness and strength ings. The present paper by Messrs. W. C. Hotherd E. L. Rhead relates to experiments on the effects ed on the metal by passing hydrogen through molten of differing degrees of purity, varying from lytic copper to copper containing up to 0·4 per cent ; and 0·4 per cent sulphur. They find that while castings cannot be obtained from copper melted carbon and not otherwise treated, sound castings obtained from metals treated with hydrogen at or 1110° C. which has been allowed to solidify in the e after treatment and re-melted. Such copper much hydrogen. Analysis shows that the atomic it of hydrogen retained is actually greater than that er impurities, the effects of which are generally reed. Micrographs of the treated metal show that ect of the hydrogen present is to cause the sulphide senide contents to be completely segregated in ens surrounding the granules of copper, thus account- the increase electrical resistance which they found rogenised copper.

*ie Effect of Progressive Cold Drawing upon some al Properties of Commercially Pure Copper.*" By ALKINS, M.Sc., *Student Member (Manchester).*

object of the paper was to give a detailed account effect of progressive cold work upon the tensile h, specific gravity, elongation, and scleroscope hardof copper of the highest degree of purity comally attainable, as it is drawn down into wire in the manner. It was found that each of these pros varied in an analogous fashion as the reduction in ncreased; the tensile strength and scleroscope hard- increased, the specific gravity and elongation ished, with increasing amounts of cold work. In case the curve showing the variation in any given rty with increasing reduction in area consisted of two hes connected by a short intermediate portion over the change became very small over a limited range luction. With heavy instead of light drafting the in the curves occurred at approximately the same perge reduction in area, but when the metal was ughly annealed previously to the drawing the break at a somewhat earlier stage and at a lower tensile gth. The agreement between the tensile strength ie elongation, and between the specific volume and cleroscope hardness, was throughout very striking. tempt was made at giving a theoretical interpretation e results obtained. The paper concluded with a reference to several points of interest which had during the progress of the work, and to methods be more strictly quantitative investigation of the problem.

*he Influence of Cold Rolling on the Physical Pros of Copper.*" By F. JOHNSON, M.Sc., Member ingham).

e paper deals with a further investigation of the ges in properties resulting from the uninterrupted olling of electrolytic wire-bar copper, commencing a thickness of 1·5 inches and finishing with a thickof 0·033 inch, the number of passes being 17. The ges in tenacity, elongation, Shore and Brinell hardlateral spread and specific gravity were determined. lotting these figures against percentage reduction of ness, it was found that there were at least two well ed critical ranges of deformation, over which the ity, elongation, and hardness remain constant, t the width of the strips also remains constant, no l spread being noticeable. There were marked inions of other critical ranges also. A few determinaof the elastic limits (or limits of proportionality) made, and they indicate a marked rise over the critical ranges. The specific gravity determinations yield no collateral evidence of the existence of the critical ranges, but concordant results were rarely obtained. By taking the tests always from the centre of the rolled strips more regularity was obtainable and an increase was observable, which was steadily maintained up to 87 per cent reduction. The author draws attention to the inequality of distribution of strains in the rolled strips both laterally, vertically, and longitudinally. Test pieces taken from the centre always yield the highest results for hardness and tenacity. Suggestions are made with a view to obviating experimental difficulties in future work. Micrographs of the series show a progressive flattening and thinning of the crystal grains until a typically laminated structure is obtained in which the grains appear as parallel laminæ. Some space is given to theoretical considerations, and the author suggests that the crystal grains are forced by the rolling process into a homotropic arrangement in which slip can occur more smoothly and readily under tensional forces over the critical ranges than at other stages of deformation where tensional and compressional forces are both in action more or less equally.

"*The Study of Thermal Electro-Motive Force as an aid to the Investigation of the Constitution of Alloy Systems.*" By JOHN L. HAUGHTON, M.Sc., Member (Teddington).

The constitution of alloy systems is generally investigated by means of thermal analysis and the microscopic examination of annealed and quenched specimens. Useful information can, however, be obtained by the study of the physical and mechanical properties of the series, and this paper deals with one of these, viz., the study of thermal electromotive force. The curves given, when the thermal electromotive forces of a series of alloys are plotted against the composition, are often very complex, but it can be shown that they are built up of branches which have one of three forms according to whether solid solutions or mechanical mixtures exist. The existence of compounds may be shown by breaks in the curves, or in certain cases by maxima or minima.

The arrangement of the constituents in an alloy may have an effect on the thermal E.M.F. The theory of this is worked out, and the results of experiments with composite copper and nickel rods are given. In this case the E.M.F. against iron is nearly 50 per cent greater when the copper and nickel are in the form of small discs in series, than when they are in the form of a bundle of parallel sheets. Practical details as to the methods employed in the determination of the E.M.F.s for a series of alloys, together with a description of a simple apparatus designed for this determination are given. The paper concludes with an appendix describing the various thermal effects, dealing principally with the recently discovered Benedicks effects.

"*The Polishing and Etching of Zinc for Micro-Examination.*" By H. H. HAYES, Member (Birmingham).

Owing to the rapid increase in the industrial use of zinc in the form of thin sheet, it has been found imperative to develop a rapid method of polishing and etching this material for microscopical examination in order to study the effects of different methods of annealing. In the method described by Mr. H. H. Hayes before the Institute of Metals, the polishing is done with Globe polish on chamois leather. No water must touch the surface during or after polishing. The etching medium is fuming nitric acid, in which acid the specimen is immersed for one second and immediately rinsed in water and dried by a hot-air blast.

"*Idiomorphic Crystals of Electro-Deposited Copper.*" By W. E. HUGHES, B.A., Member (London).

Idiomorphic crystals of electro-deposited copper can be formed at will, if suitable conditions of deposition are adopted. It was found by the author that two requisites are (1) slow disposition of the metal, and (2) as little movement as may be in the solution. A suitable device

was found to be—a small cylinder of metal, slightly hollow at one end, suspended *vertically* in the solution betweed two anodes. The solution consisted of copper sulphate and perchloric acid. Photo-micrographs of crystals of copper so formed are given in the paper. The conditions obtaining when the deposition proceeds under the circumstances stated are shown to be analogous to those in which good idiomorphic crystals are formed in salt solutions, as shown by Moore's experiments. And hence the author considers the formation of copper crystals and salt crystals to be governed by the same general laws of crystal formation. The work of Sieverts and Wippelmann and of Von Schwarz is considered in some detail.

## NOTES.

An American firm is anxious to enter into communication with an English manufacturer for the supply of ferro-tungsten, tungstic acid, and other tungstic compounds Considerable quantities are needed. Applications should be made to the Department of Overseas Trade, 35, Old Queen Street, S.W. 1.

Catalogue of Books on Chemical Technology—We have received from Messrs. Crosby Lockwood and Son, 7, Stationers' Hall Court, London, E.C. 4, their latest catalogue of books in Chemical Technology. It comprises works on Industrial and Manufacturing Chemistry (organic and inorganic) and a list of Practical Books for the Student, Analytical Chemist, Works Chemist, and Manufacturers. The publishers will be pleased to forward a copy of this catalogue to any of our readers on application.

An Early Chemical Reaction.—One of the earliest written records of a chemical reaction is to be found in the Bible—in the Book of Exodus. It will be recollected that after their departure from Egypt the Israelites marched for three days before reaching the well of Marah. On rushing to quench their thirst they found that the water was quite bitter and undrinkable. Moses, however, acting under divine inspiration, rendered the water potable by casting into it the branch of a tree. Thus far the Bible. Dean Milman, in a book written in 1846, draws attention to the scientific explanation of this phenomenon. He relates that one Buckhart, travelling through the country in which the above took place, came across a well called Howara (the identification of this with Marah is generally accepted). The water of the well was so bitter that neither men nor animals drank it. A sample of the water of a well near Howara was brought to England and analysed by a medical friend of Dean Milman, who gives the following account:—"The water has a slightly astringent bitterish taste. Chemical examination shows that these qualities are derived from the selinite or sulphate of lime which it holds in solution and which is said to abound in the neighbourhood. If, therefore, any vegetable substance containing oxalic acid (of which there are several instances) were thrown into it, the lime would speedily be precipitated and the beverage rendered agreeable and wholesome. The quantity of acid requisite for this purpose must be inconsiderable, as a pint of water, at its summer temperature in England, is scarcely capable of dissolving 20 grains of the selenite."—N. Asherson.

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THE

## ASPECTS OF CHEMICAL SCIENCE.*

By Prof. Sir WM. J. POPE, F.R.S.

tudent of the future is able to survey dispas-
: history of the nineteenth and the earlier part
itieth century he will, without doubt, insist
n the very distinct way in which these two
lifferentiated from every preceding era. The
ion of the experimental sciences which took
l the opening of last century led to an entire
e outlook of mankind upon the external world.
toric times until the introduction of the loco-
steamship, and the electric telegraph, means
cation had remained practically stationary.
rt arrangements made by Cæsar for landing
in Britain were to all intents and purposes
h those made, more than eighteen centuries
Wellington took his armies to the Continent
oleon; such minor differences as existed arose
oduction of the firearm as a scientific weapon.
placed by geographical distance in the way
er-communication had preserved its magnitude
rom time immemorial; it has diminished pro-
roughout the last century, and the past twenty
een it reduced to comparative unimportance
it of the aeroplane. It is safe to predict that
iddle of the twentieth century men and goods
portable between any two points on the earth's
ss than twenty-four hours.
east, of the methods involved in this remark-
ment of human powers of locomotion are
itood by anyone not possessed of the know-
ecialist. Man has acquired, by the invention
pliances, the power of concentrating energy
eight and compass, and using it for purposes
n; the details may be obscure, but the general
f a man can control and handle mechanical
eater than that exercised by his own muscles,
ve feats of movement and action quite beyond
y the naked savage, is quite comprehen-
ion, however, as we pass from the considera-
irely mechanical to certain of the other great
ure, difficulties in exposition and comprehen-
o arise. It appears easy to understand the
owerful mechanical appliances because their
ut multiples of those produced by our own
ems difficult to the non-technical person to
that intimate mixture of three such inert
sulphur, charcoal, and nitre, which we call
should be capable of exploding with a loud
nd with violently disruptive effects. Nature
some intuitive power of understanding purely
effects, those being needed in our ordinary
has found no need for providing us with any
ppreciating without artificial training the more
ical activities which maintain our bodies in
*the purely human point of view our natural*
understand chemical changes introduces a
ich has been existant since prehistoric times.
ress which has been made in medicine and
be quoted as an example of the operation of
ctor in the occurrences of human life which
most people more subtle in its incidence and

* elucidation than any application of merely mechanical agencies. In mediæval times a man was regarded as aged at fifty; the average expectation of life was certainly less than one-half, and probably less than one-third, what it is at present. A larger proportion of the newly born of this century survive to the age of seventy than attained the age of forty at the period of the English Reformation; life in earlier days was a nightmare haunted by apprehension of mysterious pestilences which killed at a few hours notice and by minor ailments and slight wounds which generally proved fatal. The scientific use of anæsthetics, introduced by Simpson, the scientific application of antiseptics, introduced by Lister, and the development of the science of preventive medicine, based upon the work of such men as Jenner and Pasteur, have changed all this. These new branches of science were products of the nineteenth century, and no student can doubt that they are still in their early infancy; although they embody scientific principles they have in the main progressed to a large extent empirically. *In the near future these branches of human knowledge will receive more rigid scientific treat*ment than they enjoyed in the past, and whilst the average expectation of life has been doubled during the initiation of the scientific era of medicine, it is safe to premise that within another quite short period it will be doubled again. Until a few hundred years ago a man was middle-aged at twenty-five, to-day he is middle-aged at fifty; within the next fifty years he will attain middle-age towards one hundred.

Whilst preventive medicine has put into man's hands a powerful instrument for the alleviation, or perhaps rather the postponement, of suffering, it cannot be denied that the subject has another aspect. During all time previous to the scientific development of preventive medicine a natural limit was imposed upon the size of armies; the maximum was a few hundred thousands. Every attempt to exceed a figure based on such a unit was frustrated by the onslaught of a pestilence which speedily reduced the numbers to the normal standard recognised alike by Hannibal and Wellington. Without the aid of preventive medicine any army numbering one or two million men would, within two months, be reduced by pestilence and disease to the pre-scientific standard measured by hundreds of thousands. Preventive medicine has been the enabling cause for the stable existence of armies numbered by millions of men, and has been the prime cause of the death of innumerable hosts of combatants and non-combatants—at a modest computation, fifty millions—by battle, famine, and disease over the whole surface of the globe. The potentialities for good inherent in every great branch of scientific progress are invariably reflected in potentialities for destruction.

It is to be anticipated that future progress, both in preventive and curative medicine, will be based necessarily on minute investigation of a purely chemical kind. All the diverse branches of modern medicine, whether curative or preventive, are rapidly changing and reappearing as highly specialised and very intricate sections of organic chemistry. The attack upon syphilis, which until recently was one of the several diseases generally regarded as practically hopeless, consists in introducing an arsenical compound into the blood-stream for the purpose of eradicating the organism by simple chemical poisoning, before killing the patient. The modern treatment of diphtheria, which has reduced this previously very fatal malady to comparative triviality, depends upon the application of the well known doctrine of chemical equilibrium, in which a chemical reaction, slowly progressing, is inhibited by introducing into the reacting system a considerable quantity of one of the products of the reaction. Methods of treatment, based entirely upon a sound appreciation of chemical science, have gradually and furtively taken their place in clinical work; they provide a foundation for further progress on the same lines, and we may look forward to a time when all the great scourges of the human race, influenza, phthisis, cancer, and

* Delivered before the Royal Dublin Society on February

syphilis, will have lost their horrors. From an imperial point of view, it is impossible to overrate the importance attaching to the intensive cultivation of this branch of chemical science in an Empire such as ours, which has to administer vast tropical Colonies in which malaria, sleeping sickness, cholera, and a host of other indigenous diseases have in the past impeded colonisation.

The pursuit of new scientific knowledge labours under one very grave disadvantage. It is impossible to select for study any branch of experimental science without being convinced that, no matter how remote from human interest the subject may be, sooner or later the results obtained will find practical application. The discovery of the radioactive element, radium—with all its potent consequences in revolutionising our fundamental conceptions of matter and energy—a discovery which began with Crookes and Becquerel, was brought to fruition by Madame Curie, and has yielded most portentous results at the hands of Thomson and Rutherford—has involved us more rapidly and more deeply in the subtle details of the constitution of the Universe than any other made throughout the whole history of science; yet many people already carry watches which can be read in the dark with the aid of figuring done in radium paint. The element helium was discovered by Lockyer in 1868 as existing in the outer atmosphere of the sun with the aid of the spectroscope; the statement by Lockyer that he had discovered this light gaseous element in the sun's chromosphere aroused merely academic interest, and until a few years ago helium had not been found on our earth. An inquiry initiated by the British Admiralty showed that large quantities of helium are obtainable on the earth's surface, and, had the war continued for another six months, our uninflammable airships, filled with helium, would have been dropping bombs on Berlin. Many instances similar to these may be quoted to show that every great advance in experimental science made in the past has rendered unexpected but nevertheless invaluable service in connection with practical affairs; all experimental scientific discovery, in fact, savours of the shop, and sooner or later becomes an adjunct to some object of commercial activity. The superiority of classical or humanistic over scientific studies, as instruments for the training of the intellect, lies in the freedom of the former from this taint.

One of the most striking of the many imperial aspects of chemical science is presented by the great question of the provision of nitrogen compounds. Every kind of living matter requires for its sustenance supplies of compounds which contain the element nitrogen in such a condition as to be assimilable by the living material. Even the most highly developed forms of vegetable life are capable of absorbing nitrogen from the simple types of combination of the element as ammonia, salts of nitric acid, and urea. The higher animals are incapable of utilising nitrogen presented in such simple combinations as these; they require nitrogenous food in the form of such complex compounds as the proteins or albumenoids which are present in other animals or in vegetable materials. The nitrogen thus absorbed by the animal leaves the living body by excretionary or putrefactive processes to reappear ultimately in the dead form of ammonia, nitrates, or urea. A kind of cyclic process is thus apparent in nature. The last-named simple forms of nitrogen compounds are extracted from the soil by vegetable life and elaborated into the complex nitrogenous protein suitable for assimilation by the animal; the animal returns this absorbed nitrogen to the soil by excretion or putrefaction as simple nitrogen compounds which are once more available for the sustenance of vegetable life. The animal may, of course, serve as food for another animal such as man, but this step is not an essential one. The sheep, which we eat in the form of mutton, merely acts as a kind of "middle man," passing the highly complex nitrogen compounds on from the vegetable factory to us; the devotees of vegetarianism claim that in serving this function the sheep behaves as a shameless profiteer.

The contemplation of this nitrogen cycle mak that, mainly in view of the enormous loss o nitrogen, continuous supplies of simple nitrc pounds must be provided for the sustenance anc tion of the vast quantities of vegetable matter animals need to keep them alive. It is thus ne supplement the supplies of ordinary farmyar which are useful only as providing nitrogenous c to vegetation, by other nitrogen compounds to r and to meet the constantly increasing dem growing world population.

Previous to the war the supplies of nitroge pounds thus called for were drawn in the main huge deposits of nitrates which occur as Chili and which represent the accumulation of ages o and putrefactive products of bird life in Sout During the few years before the war an averag 20,000 tons per annum of combined nitrogen ported into Great Britain in the form of Chili approximately the same amount of combined nit reserved for home use annually from the ammo produced during the production of illuminating coal. It is clear, however, that the needs of will be enormously greater than those indicated figures. The late Sir William Crookes called at this in 1898, and pointed out that only by largely application of nitrogenous manures to the soil expect to raise the production of wheat per a amount soon to be demanded for the feeding of t population; he insisted that the securing of larg of simple nitrogenous products was purely a pr the chemist, and that the question was clamant the limited available supplies of Chili saltpetre.

Having made clear the necessity for increase of simple nitrogen compounds, another side of large subject may be reviewed. Atmospheric ai ture of four volumes of nitrogen to each one o the nitrogen which is thus available in limitles is in an uncombined state, and, for all practical practically unassimilable by vegetable life. The t the chemist is indicated as that of devising pro the conversion of this gaseous nitrogen into t combined form in which it exists in ammonia, n urea, so as to render atmospheric nitrogen ava manurial purposes. This task has been acco and the intense needs of the last five years h this result of pure scientific investigation being into large scale technical practice; the vast qua simple nitrogen compounds required by Germa these years of war have been obtained almo from atmospheric nitrogen by chemical methods

In 1785 Cavendish showed that nitrogen an could be caused to combine by the passage of a spark; this observation has been utilised to b the conversion of atmospheric nitrogen into nitr a large scale by heating air in the electric arc. Deville observed that ammonia could be produc action of the electric spark on a mixture of nitr hydrogen. A technical method for the prod ammonia by heating a mixture of nitrogen and under pressure and in contact with some mater hastens combination has been elaborated as the Haber process; this process has been estab Germany on a scale capable of producing 65 ammonia per day. Later, Moissan showed intimate mixture of carbon and lime, when heat electric arc, gives the now familiar substance carbide; it was then found that when calcium heated in a stream of nitrogen, combination yield a product, calcium cyanamide, which is by water into urea and ammonium salts. This operations is now in production on an industrial

It is interesting to notice that the scientific ob upon which the three above-mentioned technical for the utilisation of atmospheric nitrogen are b made in England and in France, but that the

mselves were first worked out and installed It is further of importance to note that such en compounds as nitric acid and ammonia sentials in the manufacture of military ex- t the chief sources of these nitrogen com- until quite recently found in Chili saltpetre, import of Chili saltpetre into Central Europe once stopped by war; also that Germany did upon a world war until the several methods g atmospheric nitrogen into the nitric acid he manufacture of great supplies of both pro- shattering explosives had been worked out ca e as rendered Central Europe independent Chili saltpetre as a raw material. which certainly lean towards the conserva- the requirements of combined nitrogen for ses in the United Kingdom are given in the ished Report of the Nitrogen Products Com- ument worthy of serious study by everyone the future of our Empire. Immediately prior riculture in the United Kingdom absorbed an ge of 25,000 tons of nitrogen in the form of lisers; the present demand of agriculture in Kingdom is estimated as 60,000 tons per the possible demand in the near future as per annum of combined nitrogen. Small supply of the difference between 25,000 and per annum of combined nitrogen will be met of our manufacturing and export trades; a will be met by starvation. The only method of ecies of nitrogen bankruptcy of the Empire tallation on a huge scale of the several types utilising atmospheric nitrogen.

portant from the Imperial point of view is d large-scale exploitation of the limitless our colonies in the shape of raw materials for ture of edible fats and oils. The fatty ich we consume are utilised in the animal nly for the provision of the energy which we heat and in muscular effort. It is curious to e actual material consumed acts merely as a nergy which it brings with it in a form avail- al use, and that the margarine produced by hods from palm kernel or cokernut oil, which ly serves as a carrier to our bodies of heat ted from the sun into one or other of our ies. Great as has been the development of fic industries which involve the conversion of ls into common foods by chemical methods st five years, much still remains to be done to tropical products.

ow pass from this brief and inadequate dis- he great Imperial aspects of chemistry which maintenance of connection between body the consideration of several other large blems which our Empire has to solve.

nown that the industry concerned with the of the so-called coal-tar colours was founded ely scientific chemical work of the late Sir kin, and that the industry, started in the dom, soon languished with us and became great and most profitable of German manu- revious to the war we imported some worth per annum of these dyestuffs from Ger- e stoppage of this importation paralysed our tries, which represents financial interests a es as great. The early coal-tar dyes were evanescent, and in point of fastness against shing fell far behind the few natural dye- ly in use; in this they probably but followed for the demand came for light fabrics of s capable of withstanding much less rough e more substantial heavy cloths which our ffected. The progress of chemical science r, to the discovery of more stable coal-tar the present time a variety of such substances extraordinarily resistant to change is available; some of the artificial vat-dyes now manufactured are so inert towards the agencies which promote decay that they persist unchanged in shade even after the fabric carrying them has rotted away.

Few industries than that of coal-tar colour manufacture reveal more clearly the necessity for continual chemical investigation of a highly original order for the purpose of securing such developments as will best serve the incessant demand for improvement; like all chemical industries it depends for progress upon the intimate association of advance both in the science of chemistry and in the art of engineering, but this association of very diverse factors is less evident in most other large industries. The national importance of the synthetic dye industry has at length been brought home to our administrators, and Government support is now being extended to attempts, strenuous but tardy, to establish manufacture and invention on a scale commensurate with the needs of the Empire. The facility with which we have allowed German enterprise and industry to develop the artificial colour industry is surprising when we reflect that our colonies were at one time producers of the main bulk of the world's indigo supply; we allowed synthetic German indigo to oust British-grown natural indigo from the market absolutely without any attempt at competition from our colonial growers. Natural indigo has qualities as a dyestuff, due to its content of other and allied colouring matters, which render it in many ways superior to the pure synthetic material; it is in the highest degree probable that the scientific cultivation of the indigo plant, the scientific improvement of the archaic methods still in use for extracting the dye from the plant, and the scientific standardisation of the natural product, would have effectually prevented synthetic indigo from gaining a remunerative market. Much valuable work has been done recently by Armstrong and Davis on the improvement of the cultivation and extraction of natural indigo. A very similar problem arose when economic reasons led to the need for extending the beet-root sugar industry in competition with cane-sugar; seventy years ago the German manufacturers separated from the beet about 5 per cent by weight of sugar; by scientific cultivation and scientific extraction they succeeding in separating from the beet more than 20 per cent of its weight of sugar. If the yield of indigo from the plant could be similarly increased four-fold synthetic indigo would disappear from the market.

Innumerable other instances might be quoted to show that neglect of the Imperial aspects of certain great branches of chemical science has led us to the brink of disaster. For high class pharmaceutical products, for glass apparatus such as chemical glass and optical appliances, for many essential metallic elements and alloys, and for other raw materials and final merchantable articles, all needing in their manufacture the application of perfected chemical methods, we have been content to rely on Continental industry and foresight; very often, indeed, we have neglected natural sources which occur solely in certain parts of the British Empire and have allowed the German manufacturer to acquire the monopoly of their exploitation.

The dangers which result from complacency such as this may perhaps not be immediately obvious in times of peace, but the establishment of a state of war renders them imminent. Previous to the war we were content to allow ten-elevenths of the world's demand for quinine to be produced in the island of Java; this material can be easily grown in several of our colonies. A large army suffers more loss from a shortage of quinine than from military operations. Should war catch us again without a reserve of a hundred tons of quinine actually among our military stores it should be regarded as criminal neglect. Similarly, our Empire has been content to draw most of its bromine from Germany; since bromine and bromides are necessary in medicine and in manufactures the stoppage of imports led to considerable embarrassment. We can

probably produce bromine more cheaply than Germany from the residues left in the production of salt from sea-water on the Indian coasts.

It must not be concluded that reflections such as these upon our past policy are of the nature of mere carping criticism. We have all received a very intensive education since the autumn of 1914; there is no merit in being wise after the event, but it is very essential that the lessons administered should profit us in the future. A consistent disregard of the Imperial aspects of chemical science previous to the war cost us hundreds of thousands of valuable lives during the war, and has post-war consequences which will influence our general prosperity adversely for some indefinite period yet to come.

It is noteworthy that the chemical works in Germany, the creation of the last fifty years, are capable of providing between them a considerable proportion of the world's requirements of chemical products of every kind, from the most inexpensive chemical substances right through a long series to the most costly, because the most difficult to manufacture, of the fine chemicals possessing any technical importance. Furthermore, the German chemical firms are all affiliated under one great central control, the object of which is to protect and advance the collective technical chemical interests of the nation. The United Kingdom has always been the seat of a flourishing chemical industry, which, however, only embraces certain sections of technical chemistry; many of our great chemical firms are at least as efficient as any on the Continent, but, whilst our manufacturing industry has specialised upon more or less isolated patches of the great subject of chemical technology, we have been content to rely upon the German works for many expensive, but absolutely essential, chemical products. Further, the British chemical works have not co-operated in the establishment of a comprehensive organisation for mutual protection; some may question whether such a union is in the interests of the nation, but the important point for the moment is that we have had no such co-operative system of working.

With these essential differences between German and British practice in mind, the immediate effect of a declaration of war can be realised. In Germany, mobilisation meant the cessation of peace production and the concentration of effort on war production under the auspices of a central control well acquainted with the potentialities of each component factory; the type of organisation existing lent itself to rapid and efficient production on a war footing. The autumn of 1914 found Great Britain with a chemical industry which had never produced a large number of chemical materials needed for military consumption and with no organisation which could bring all the different works into co-operative production upon the new basis; in fact, no single authority, whether an individual or a corporate body, existed who had more than a vague knowledge of the potentialities for production of the chemical works of the United Kingdom. The utmost confusion prevailed for a lengthy period and was only slowly and incompletely dispersed by the intense labours of the newly established Ministry of Munitions.

The task of working up the Explosives Department of the Ministry, which was allotted to Lord Moulton, involved the manufacture of some 2000 tons per week of propellant explosives, chiefly cordite, 1000 tons per week of picric acid, 2500 tons of T.N.T. per week, and 3000 tons per week of ammonium nitrate, together with enormous quantities of essential auxiliaries, such as nitric and sulphuric acids, alcohol, and acetone. The scale of production attained by this Department constitutes one of the great achievements of the war; it is a remarkable tribute to the power of co-ordination exerted by its chief and to the enthusiasm with which our great chemical firms and the departmental staff of chemists and engineers co-operated in its establishment. It is true that many mistakes were made, but it is equally true that our enemies, in spite of their already existing organisation and powers of production, fell into more numerous disastrous errors.

In one respect the chemical manufactories
Europe still retain an important advantage ov
the United Kingdom. The German works
greatly extended during the war, but owing t
existence of a highly efficient organisation i
possible to carry out the developments called
creasing military demands in such a manne
whole can be effectively utilised on demobilisa
much larger peace production. The major port
new works established in Great Britain were of
designed purely to meet war requirements, and
to all intents and purposes useless. Whilst
these works are now entirely derelict the corr
German works are ready to meet far greater ca
peace production of important chemical subs
this respect Germany leaves the war better equi
manufacturing competitor than when she entere

The maintenance of a kind of census upon the
of production of the chemical works of the co
of a sort of control to ensure that the country
mand under any prevailing external conditions t
quantities and varieties of explosives for milita
essential. This is an Imperial aspect of chemic
neglect of which will not be susceptible to r
the future as it has been in the past. Th
requires to maintain intact its large heavy
industry, the manufacture of alkalis and their co
and of common acids, and all those chemical
concerned with metallurgical products and comp
the metals, and to ensure that it is capable of
home, colonial, and certain foreign needs on a co
basis under peace conditions, and all probable ho
in time of war. A flourishing fine chemical
capable of producing synthetic dyes, pharmace
photographic requisities, and large numbers
organic compounds for which the demand is
imperative, is also essential to the well-bein
Empire in either peace or war.

Everyone is aware that the German and th
British coal-tar factories have played a large p
provision of high explosives during the last few y
any future war they will undoubtedly play a m
part in view of the introduction of poisonous m
a new military weapon. The use of poisonous
in warfare is forbidden by the Hague Conve
notwithstanding this the Germans launched an
the Allies with the poisonous gas, chlorine, on
1915, and it soon became clear that this oper
but the precursor to an elaborate programme for
sive use of such materials. This action was gre
universal horror, but the disgust expressed mus
posed directed not against the use of poisonous
against their use in the face of a covenant to
that they should not be used.

Apart from this vital point there seems little
reason why poisonous materials should not b
warfare; it is no less noble and chivalrous an
kill an individual one never meets or sees by
poison gas or to leave him to die miserably
trouble caused by mustard gas than it is to te
testines to pieces by high explosive shell fired a
of twenty miles. Every advance in military sc
aroused a storm of execration; the use of large
cally actuated catapults, which were introduce
the twelfth century, against Christian troops
bidden by the second Lateran Council unde
excommunication.

Over 30 per cent of all the casualties suffer
American armies in Europe were due to chemical
this preponderating effect of one arm produced
time after its introduction, added to the heavy
equipment required for protection against gas,
certain that chemical warfare will become one o
factors in future military struggles between

The whole subject has been developed hurriedly nergency basis, and will be necessarily perfected a degree during the coming years of peace as will he effects of chemical warfare catastrophic to the l prepared of two adversaries.

provision of the offensive and defensive needs of il warfare constitutes an Imperial aspect of chemical upon which our whole future existence as an may depend. The investigation of the possibilities ie needs calls, in the first place, for chemical re- of a high order of excellence; the provision of the an only be met by the establishment of a large and ing fine chemical industry within the United m.

ll be remarked that I have laid stress in this lecture upon the achievements of chemical technology, ve dwelt upon the necessity for intensive develop- i our islands of a branch of human activity which en neglected to such an extent as constitutes an il danger. This must be considered, however, in ction with the undoubted fact that all progress in al technology originates in scientific discovery and esearch which, in the majority of cases, is under- vith no eye to its future use in manufacture. The of science abounds in illustrations of this principle. irely scientific discovery of benzene in oil-gas by y formed the foundation of the greater part of the iemical industry; the pioneer scientific work of y, Andrews, and Dewar on the liquefaction of and of Cavendish and Deville on the combination igen with oxygen and hydrogen, laid the foundation great industries for the utilisation of atmospheric m. Pure scientific investigation is carried out for rpose of increasing our knowledge and enlarging nception of the universe; its technical applications that we have to depend upon in the now necessary of increasing production whilst simultaneously shing the burden of manual toil. The stimulation ly scientific studies must thus be the prime care of e interested in the Imperial aspects of chemical e; the encouragement of scientific research in our sities and colleges calls for much greater expenditure ught, effort, and money in the future than in the past part of all who have at heart the welfare of our e.

## UFACTURE OF WAR GASES IN GERMANY.*

By JAMES F. NORRIS.

paper by Lieut.-Col. Norris is based on his official of inspection of chemical plants at Leverkusen, st am Main, Biebrich, and Ludwigshafen in the ied zone of Germany. In addition to the manu- e of poison gases, attention is also paid to the manu- e of synthetic rubber and of charcoal for gas masks. ber was manufactured from acetone. This com- l was reduced to pinacone by means of aluminium ydroxide. The pinacone was distilled under pres- it thereby lost water from its molecule, and yielded illate of methyl butadiene, an unsaturated hydro- n. Polymerisation was produced by heating this carbon at a temperature of approximately 600° C. period of four to six months; the product of methyl r was a clear, tough, white, transparent mass, with roperties of the best caoutchouc, and was used in nanufacture of automobile tyres and other rubber ...

ircoal for gas masks was made from pieces of wood lly pine) of even size and one-fourth inch in diameter. were soaked for at least thirty minutes in hydro-chloric acid of 30° to 40° Baumé, to which a small bu indefinite amount of zinc chloride had been added. They were then packed into a muffle, which was 24 inches square by 12 feet long, until only a few inches of air space remained above the pile of wood. The muffle was provided with an iron door, a lining of porcelain tile, and a stoneware flue pipe, which led to an hydrochloric acid condenser plant. Carbonisation occurred slowly and very thoroughly; the muffle was heated to a cherry red, and heat was applied for at least six or eight hours. The charcoal was washed with hydrochloric acid until the soluble ash had been reduced to a minimum, and the finished product contained approximately 0.01 per cent of zinc. It was next washed free from acid. The total time required for washing was two or three days. The charcoal was then drained on a drill, dried in vacuum at 70° to 80° C., and finally sifted in a rotary sieve to remove the dust.

The processes used in the manufacture of the various poison gases may be briefly outlined.

Mustard gas, or $B_1B'$ dichlorethyl sulphide, was manufactured from common grain alcohol. Ethylene was obtained by passing alcohol vapour over aluminium oxide at a temperature of 380° to 400° C. Ethylene chlorhydrin was prepared by passing carbon dioxide and ethylene into an aqueous solution of chloride of lime. By reaction with sodium sulphate, the chlorhydrin was changed to $B_1B'$ dihydroxy ethyl sulphide; this compound was converted into mustard gas by treatment with hydrogen chloride. The mustard gas was used as a solution in either chlorbenzene or carbon tetrachloride.

Perchlormethyl formate, also called trichlormethyl chlorformate, diphosgene, or superpalite, was manufactured by two processes. Methyl formate was made in the usual way, then chlorinated under the influence of high candle power lights with osram filaments. Or methyl chlorformate was prepared by the reaction of phosgene (carbonyl chloride) and methyl alcohol, and was then chlorinated.

The raw materials for the manufacture of diphenylchlorarsine or blue cross gas were aniline and arsenious oxide. The diazotised aniline hydrochloride was permitted to react with sodium arsenite in the presence of cupric sulphate to obtain the sodium salt of phenylarsenic acid. This acid was liberated by addition of hydrochloric acid, then reduced to phenylarsenious acid by use of sulphur dioxide. The sodium salt of phenylarsenious acid was next condensed with diazobenzene chloride to obtain sodium diphenylarsenate, which yielded diphenylarsenic acid when treated with hydrochloric acid. The diphenylarsenic acid was reduced to diphenylarsenious oxide by means of sulphur dioxide. This oxide was immediately converted into diphenylchlorarsine by hydrochloric acid, which had been added to the reaction mixture.

Diphenylcyanarsine was made by treating diphenylchlorarsine with either sodium cyanide or potassium cyanide.

In the manufacture of ethyldichlorarsine, ethyl chloride was made to react with sodium arsenite to obtain sodium ethylarsenate. The solution of this salt was made neutral, treated with an excess of sulphur dioxide, and heated to 70° C. The ethylarsenic acid was reduced to ethylarsenious acid, then converted into the anhydride of the latter, *i.e.*, ethylarsenious oxide. This oxide was changed into ethyldichlorarsine by treatment with hydrogen chloride.

Phenyliminophosgene was made by the action of chlorine on phenyl mustard oil.

Symmetric dichlor methyl ether was obtained by the action of chlorsulphonic acid on either paraformaldehyde or an aqueous solution of formaldehyde in the presence of sulphuric acid and water. Symmetric dibrom ethyl ether was manufactured in exactly the same manner except that ammonium bromide was substituted for chlorsulphonic acid.

Bromacetone and brommethylethyl ketone were made om acetone and methylethyl ketone respectively by treat-

* ...stracted in the *Journal of the Franklin Institute*, December, rom the *Journal of Industrial and Engineering Chemistry*, 817.

ment with bromine and chlorate of either sodium or potassium in aqueous solution.

Xylyl bromide was prepared by bromination of xylene, chlorpicrin by the reaction of picric acid and bleaching powder.

Phosgene was obtained by the union of carbon monoxide and chlorine in the presence of a carbon catalyst, which was prepared from wood charcoal by treating with hydrochloric and other acids until entirely free from soluble ash, washing, and drying in vacuum. Animal charcoal yielded an even better catalyst. The charcoal was used in fragments of approximately one-fourth inch mesh, and retained its catalytic activity for about six months. The carbon monoxide was prepared by passing carbon dioxide over charcoal in gas-fired muffles and washing with sodium hydroxide.

The average monthly production in tons of certain of these poison gases was—

| | |
|---|---|
| Mustard gas .. .. .. .. .. .. .. .. | 300 |
| Diphosgene .. .. .. .. .. .. .. .. | 439 |
| Diphenylchlorarsine .. .. .. .. .. .. | 150 |
| Ethyldichlorarsine .. .. .. .. .. .. | 78 |
| Phosgene .. .. .. .. .. .. .. .. .. | 318 |
| Phenyliminophosgene .. .. .. .. .. .. | 65 |
| Dichlormethyl ether .. .. .. .. .. .. | 26 |
| Dibrom methyl ether .. .. .. .. .. .. | 7 |
| Chlorpicrin .. .. .. .. .. .. .. .. | 245 |
| Xylyl bromide .. .. .. .. .. .. .. .. | 55 |
| Bromacetone plus brommethylethyl ketone . | 19 |

## OPTICAL GLASS AND CHEMICAL GLASSWARE.*

Of the many industries that have been developed in this country by the necessities of the war, few, if any, have had such brilliant success as the manufacture of glass for scientific purposes. The lack of supply for these purposes began to be felt as soon as the British blockade became effective, and by 1917 the attention of American scientists and officials had been strongly directed to the problem of home manufacture. Optical glass has for many years been imported, principally from Germany, but some from France and England. It was not made in the United States. Rough or unwrought optical glass has been for years on the free list. At the present time through the large experience and organisation developed by the necessities of the case, the optical glass industry in the United States has the scientific knowledge, materials, and equipment to compete in regard to quality of product with the best of foreign manufacture. Still the whole demands of the market are not met, for in 1918 we were obliged to import about one-half the normal amounts of unwrought glass and in addition large amounts in the form of optical instruments. Scientific authority informs us that four kinds of optical glass are the most needed—A very light and transparent crown, an ordinary crown of higher index, a typical heavy flint, and a typical light flint. Next to these most important forms, are a heavy barium crown and a light barium flint especially used in photographic apparatus. The further development of these industries cannot be expected if such products are kept on the free list or subjected to merely nominal duties, and, moreover, the present condition by which all educational institutions are permitted to import even complete optical instruments free of duty will seriously interfere. Glass makers are asking for the repeal of this clause, a request which has met with a good deal of approval from the scientific workers of the country.

Chemical glassware, generally known in th "hollow ware," is used in enormous amou United States, and has been for many yea entirely supplied by Germany and Austria, t brands being among the most familiar titles in tory. This supply also being shut off, the a American glass-makers was directed to finding s and here, as in the case of the optical glass, gr has been achieved. Indeed, it is now generall that much of the American glass is better tha has heretofore been obtainable from abroad. Fac ware of this high quality is now being mad American factories that were in active ope ordinary glass-making before the war. These turers express confidence that they can main industries without increase of the present duty cent *ad valorem*, but ask that the duty-free cla cable to scientific institutions which are very l of these forms of glassware owing to the stude tories, be repealed and that all chemical glasswar dutiable at the 45 per cent rate. Here again t sions of chemists and officers of scientific i are largely favourable to the repeal. Statistics before the war the duty-free importations am about half of the value of the total imports bas invoices.

The Bureau of Standards has made thorough tions of the American ware in comparison wit foreign ware, and reports that all the former a to the Kavalier ware and equal or superior to ware for general laboratory use.

* Abstracted in the *Journal of the Franklin Institute*, December, from the *U. S. Tariff Commission Information Bulletin*.

## UTILISATION OF NITRE-CAKE.

By GILBERT T. MORGAN.

Nitre cake is the residue of the action of sulp upon sodium nitrate, and consists mainly of so sulphate. During the war British munition indu duced enormous quantities of this material, or alone having an output of over 200 tons per we of which was dumped into the sea. When the o much smaller, as in peace times, the material wa for the manufacture of salt-cake and hydrochl the former being employed in the Leblanc pr sodium carbonate. Some of the nitre-cake was into sodium sulphide, which is now used as a agent in organic syntheses.

Morgan sought for some methods which wo the sulphur as well as the sodium. He re methods already known, and then describes a devised by himself in which the cake is used fo duction of soda-lime and soda-lead glasses at o tion with recovery of the sulphur, either free o phuric acid. It will suffice to describe briefly on procedures.

Seventy-two grms. of nitre-cake, 100 grms. of grms. of limestone, and 4 grms. of wood charc heated in a fire-clay retort connected with a m leaden chamber. The fixed product was clear gr the volatile products were sulphuric acid, sulphu and free sulphur. The heating was continued f hours, but the bulk of the volatile products was in the first two hours. The volatile products w mixed with steam, air, and nitrous fumes for c The analytical figures show that over half th can be recovered either as sulphuric acid or as element.

* Abstracted in the *Journal of the Franklin Institute*, 1919, from the *Economic Proceedings, Royal Dublin So* ii., 198.

## THE COLOURS OF COLLOIDS.*

By WILDER D. BANCROFT.

*Glasses and Glazes.*

ised glasses may contain the colouring matter dis- or in colloidal solution. This seems to be generally lised, because Heaton (Thorpe, "Dictionary of :d Chemistry," 1918, II., 721) says that coloured s may be divided into classes :—

Those in which the colour is introduced by a coloured und of the metal in a state of solution in the glass ; case the intensity of the colour is proportional to ncentration of the solution of colouring material.

Those in which the colour is due to the optical of minute particles held in suspension by the glass ; he colour depends upon the size and distribution of rticles.

s is an admirable start ; but it does not get us any- :, because we are not told, except casually, which s belong in the first class and which in the second. : is also a very great haziness as to the actual nature colouring matter in many cases. It will not be le for me to clear up this matter from the data lly available ; but a presentation of the subject will nly be interesting and should be helpful.

th glasses coloured by gold, silver, or copper we that there is a second phase because the ultra- scope shows it to us and because the characteristics glasses are those of colloidal solutions. The true glass is coloured by metallic gold and has some very sting properties (Zsigmondy, "Colloids and the -microscope," 1909, 165.) Fused glass containing all amount of gold is colourless and remains colour- f cooled quickly. If cooled slowly or if reheated to a erature well below the melting point, it becomes red g to the separation of particles of gold of the size to mit red light. If held too long at a high tempera- the red colour changes to a violet and then to a blue. e are exactly the changes that we get in aqueous ions and for the same reason, the increase in the size e particles. It is not quite clear, however, why the lly cooled glass should be colourless. The simplest nation is to say that we have an unspecified salt of in true solution. This is the attitude of Wolfgang ald ("Theoretical and Applied Colloid Chemistry," , 186). "Ruby glass owes its red colour to the nce of colloidal gold. I show you three specimens h are 'solid solutions' of gold in three very different acteristic degrees of dispersion. The first is an st clear but slightly yellow mass of glass. This is ined immediately after dissolving the solid cold salt in glass. There is obtained in this way a molecularly rsed solution of the gold in the glass and one which, onsequence, is ultra-microscopically empty. The nd preparation is the ordinary ruby glass in which gold is obtained in a colloidal state. The third speci- is deep blue by transmitted light and orange brown flected light. The specimen is also distinctly turbid. prings from a failure in glass manufacture in that, umably, through a too long heating of the glass, a ulation of the red gold particles to the more coarsely ersed blue particles has taken place—just such a ge as I showed you in an aqueous dispersing medium n I coagulated the red gold (produced through re- ion of gold chloride by tannin) to blue gold through addition of acid. These same facts as illustrated in case of glass prove of what little importance is the of dispersing medium and how much depends upon legree of dispersion in determining the variations in ur of this substance."

he colourless glass cannot be due to the formation of ld salt because the same phenomenon is observed n the glass is heated in a reducing atmosphere. Either the gold is in true solution in the glass or it has been peptised so that the colloidal particles are too small to have any effect upon the beam of light. Zsigmondy ("Kolloidchemie," 1912, 28) believes that the colourless glass is a true solution of metallic gold in glass ; but he does not give any satisfactory reason for this. It would be interesting to see how glasses richer in gold behaved when heated. The tinctorial power of the gold is very high, 0·01 per cent giving a pink colour and 0·1 per cent a red. The number of colloidal particles is enormous, billions per cubic millimetre according to Zsigmondy. The smallest particles visible in the ultra-microscope have a mass of about $10^{-15}$ mgrs.

The cheaper form of ruby glass owes its colour to colloidal copper and the red in some glazes is due to copper in some form. The Chinese ox-blood is believed by Lauth and Dutailly to be metallic copper in tin oxide. The copper oxide is reduced to metallic copper, this being dissolved in the glaze and imparting to it on cooling a copper-red colour, while on more rapid cooling a colour- less glaze is produced, which, however, becomes red on slow gradual heating. Seger ("Collected Writings," 1902, ii., 734), does not agree at all that the production of the red colour is due to a segregation of metallic copper simply by a strongly reducing firing. His own experi- ments showed that alternately reducing and oxidising conditions of the fire gases are required in order to pro- duce the red colour. The difficulties of the manufacture lie less in the composition of the glaze than in the com- position of the fire gases. Using one and the same glaze, the shade of the colour is subject to extraordinary fluctua- tions running from black through brown to sealing-wax red and light bluish green. Some pieces are coloured differently on one side than on the other according to the intensity of the draught through the saggars. With the same glaze some burns may produce a beautiful colour while others may not show any red colour at all, every- thing coming out grey or black.

"Now let us see how cuprous glazes behave in a reducing fire or fusing in a reducing gas, and let us first take such whiteware glazes free from lead, which beside copper oxide contain no other metallic oxide that could be reduced. For example, a glaze having the stoichio- metric composition

$$0·5\ Na_2O,\ 0.5\ CaO,\ 2·5SiO_2,\ 0·5\ B_2O_3,$$

a glaze which melts smooth at about the melting point of silver, and is made by fritting together

| | Parts. |
|---|---|
| Pure sodium carbonate .. .. | 26·5 |
| Marble .. .. .. .. .. .. | 25·0 |
| Ground quartz .. .. .. .. | 75·0 |
| Hydrous boric acid .. .. .. | 31·0 |

and which, after the melting, is ground together with 1 per cent of copper oxide. This mixture is put into a small porcelain crucible which is placed in a platinum crucible ; the crucible is provided with a perforated porce- lain lid and through the opening a thin porcelain tube is introduced, as in the Rose reduction crucibles of the laboratories. The mixture is not put into the platinum crucible directly in order to prevent the platinum from alloying with the copper of the mixture.

"If we heat the glaze mixture in a stream of hydrogen or carbon monoxide introduced through the porcelain tube, to dark red heat, that is, to 400° or, at most, 500° C., the copper oxide is reduced and the glaze does not melt but is only fritted together. It has a red colour caused by the copper segregated out.

"If we now apply a higher heat, maintaining a current of hydrogen or carbon monoxide, about to silver-melting heat—the highest temperature obtained by a Bunsen burner—the metallic copper disappears, the copper flakes dissolve in the melting glaze, the red colour vanishes and the completely molten glaze has now received a greenish grey colour. If we coarsely powder this grey mass and

* From the *Journal of Physical Chemistry*, xxiii., No. 9.

again melt it together with the same white glaze, to which a trifle of some oxidising agent is added, say 1 per cent of ferric oxide, stanic oxide, or a sulphate, like gypsum, but this time in a stream of air, in the crucible of the test kiln mentioned below, there is obtained a glass of a beautiful red colour.

We must attribute this reaction to the fact that by the oxidising agents which are contained in the glaze free from copper, the black metallic copper enclosed in the copper glaze is changed to cuprous silicate, and this imparts to the glass a red colour, for the ingredients react as follows:

$$2Cu + Fe_2O_3 = Cu_2O + 2FeO$$
$$2Cu + SnO_2 = Cu_2O + SnO$$
$$2Cu + SO_3 = Cu_2O + SO_2$$

"The last reaction is remarkable, owing to the fact that a lively evolution of gas takes place in the fusion. If the glass is allowed to cool, before it has become entirely clear, thus still retaining some bubbles, the presence of sulphurous acid can be proved by the smell on opening the bubbles.

"If we now produce a glaze of a higher melting point, mixing the whiteware glaze given with the white porcelain glaze mentioned above,

$$\left.\begin{matrix} 0{\cdot}3K_2O \\ 0{\cdot}7CaO \end{matrix}\right\} 0{\cdot}5Al_2O_3{\cdot}4SiO_2,$$

we obtain a glaze which at silver-melting heat only vitrifies but does not fuse. This glaze consists of 25 parts of the above copper whiteware glaze and 75 parts of the porcelain glaze. If we heat this likewise in a crucible, as was done before, at a silver-melting heat, introducing hydrogen gas or carbon monoxide, we again obtain a grey vitrified mass. On heating this in air, that is, in the open crucible, we observe that it assumes after a short time a reddish brown or red colour, which however, fades quickly, and whose place is taken by a light green colour. We also observe in this connection that the strongest reducing action of the gases produces a black colour, since it causes the reduction to metallic copper; that on admission of air this changes to a red colour; that the copper is first changed to cuprous silicate; and that finally the green colour of the cupric silicate appears.

"If we heat the mixture more strongly over the blast-lamp, admitting a reducing gas, so that the glaze is fused, the mass thus formed remains grey in colour and on heating in the air turns to a reddish colour only on the surface, but in the interior it retains its grey colour. On the vitrification of the glaze, further oxidation (and with it the red colour) is excluded. A striking phenomenon is at the same time caused by the carbon deposited in the glaze. If the reduction is accomplished with illuminating gas instead of with hydrogen or carbon monoxide, a part of its carbon is deposited owing to the decomposition of the gas, which surrounds the glaze particles and thus prevents fusion. The glaze thus becomes apparently less fusible and retains its porous character even at the temperatures which lie above its melting point. If glazes, reduced in this manner, are heated in the air, the carbon is burned out, but at the same time the copper segregated out is also oxidised to cuprous oxide and the glaze is now enabled to fuse. In this manner red glazes are always produced.

"These experiments, performed in the crucible with pure reducing gases, were supplemented by others carried on in the test-kiln, using a small test-kiln fired with gas. This little furnace not only increases the rapidity of the experiments, but it also enables the experimenter to effect alternate reducing and oxidising kiln conditions quickly and to control them by gas analysis. As trial pieces there are used small cups of biscuit-burned porcelain body, coated with a glaze, composed of 25 parts of whiteware glaze compounded with 1 per cent. of copper oxide and 75 parts of porcelain glaze.

"On heating these in the kiln, first in an oxidising flame, until a glow is just visible, then in a s reducing flame, so that about 10 per cent of monoxide is contained in the fire gases, up to a t ature not exceeding gold-melting heat, we obse pulling small glazed trials from the kiln with a tongs that the glaze as well as the body possesses colour due to the deposition of carbon.

"If we now allow the kiln to cool and do not cl damper so the air passes through the kiln fo time, we observe that the vitrified glaze coating t come beautifully red. When we fire under the sa ditions, but higher, up to the temperature of cone we obtain a fused glaze, grey in colour, whi properly melting the glaze in the oxidising flame a cone No. 1, changes more or less to reddish or br but never assumes a fine red colour. Repeating th operation with another small porcelain cup, but lower content of carbon monoxide in the fire gases per cent) the grey colour appears still more intensel

"On firing a trial cup so that we first burn strongly reducing flame about up to silver-melting and then burn alternately with a strongly reducir oxidising fire up to incipient fusion, about five m reducing and two minutes' oxidising, and after the of the glaze finish the burning of the porcelain oxidising flame, we obtain a fine red glaze. Th glaze is retained quite satisfactorily in the oxidisi after once it is fused, and it can remain in the latter six hours without changing in colour, though on th face it may assume a pale green colour due to oxi This nearly colourless, extremely thin surface c produced by oxidation gives to the pottery a special Only when the glaze is very thin is it possible th change in colour might extend through the entire ness of the glaze on remaining in the oxidising atmo for a longer time, and such thinly glazed places, s as the edges, and the relief decoration under the assume a green colour.

"It is of special importance in the burning of t glazed porcelain that the fire be very sooty. Betwe sagger rings which form the stack of saggars, I always inserted on top and at the bottom of the ri the height of the ware, three small pieces of fire-cl of 1·5 to 2 cm. in thickness, so that the flame was admitted to the ware, and could always draw freely th the saggars. The deposition of carbon from the fire has by no means the purpose of bringing about strong reducing effect, for the copper oxide is chang copper even under weakly reducing conditions, should be the function of the carbon to retard the of the glaze by depositing the soot in it. If now oxi conditions are suddenly brought about, avoiding n firing conditions as much as possible, the copper, the burning out of the carbon from the glaze, changes to cuprous oxide and is retained as such I glaze which is fused soon after this change in When the burning is accomplished without the depo of soot on the surface of the ware, the red colo never develop, and the copper glaze alway assumes colour, since then the closing of the pores of the is not retarded and the metallic copper segregated deprived of the possibility of reoxidizing to cuprous

"An experiment which I carried out endeavouri burn a glaze, burning to a beautiful red with wood a in a gas-fired kiln, using coke as a rule, failed en grey coloured ware was always obtained.

"Although on following the rules outlined above, colour can be produced from every cuprous glaze crucible or in the small experimental furnace, the tions in the large kiln are essentially different. It w always be possible to produce a uniformly reducing a phere with a deposition of soot and it is especially di to produce strongly oxidising conditions during s time interval (one to two minutes); the red col using any cuprous glaze will be obtained only rare in exceptional cases. But the production of th

may be facilitated by imparting to the glaze a chemical and physical constitution.

ne means of accomplishing this purpose consist first nall addition of ferric or stannic oxide, in order to *ependent of the oxygen of the atmospheric air alone* translation of the copper to cuprous oxide. These ic oxides are likewise changed to ferrous oxide and ous oxide, but their re-formation to the higher oxides place quickly and thus they are enabled to oxidise pper. Although an addition of these oxides by no *prevents the formation of the grey colour, yet in* presence the red colour appears much more readily. in or iron oxide is best melted in quantities of not *than 2 per cent, together with the copper oxide* and ery fusible whiteware glaze which serves as a frit.

he quantity of copper oxide which is used is also of *importance for the beauty of the colour. In my* experiments I have always used a content of copper n 0·5 to 1 per cent and always obtained very good s. The more copper oxide there is in the glaze, the er is the liability of some of the grey colouring lic copper to remain in it and to change the sealing-*ed colour* which is produced by the pure cuprous into a brownish colour. With a content of er cent of copper oxide to 100 parts of the finished *lain glaze*, the glaze where it is coloured red is per-opaque. For transparent red glazes which, on nt of their transparency, receive a deeper red colour ir to gold-ruby, I have always used 0·10 to 0·15 per of copper oxide. With this content of copper oxide laze tends to produce green colours more readily, but e same time the portions which have retained the olour are so much more beautiful. In regard to the tity of the very fusible whiteware glaze (serving as a frit) ssary, this will always depend upon the temperature hich the body must be subjected in order to burn it to porcelain. It may vary from 12 to 50 per cent of nished *glaze*. The more fusible the glaze is to be ower in silica it must be kept, the smaller may be its tity, and the more beautiful will be the red colour oped; the less fusible it is, the more difficult is the action of the red and the more readily will the grey ir of the ware be shown. As to the composition of porcelain glaze being a component of the glaze, I discussed it in the introduction; other porcelain *es may very well be used, but care must be* that the mixture remains as porous as possible; l porcelain glazes cannot be used for this purpose as are too dense.

Fluctuations in the composition of the white porcelain are permissible according to the composition of the and the temperature it requires; care must be taken, ever, that it does not vitrify at too high a temperature, h is controlled by the addition of a very fusible white- glaze. Whatever the composition of the glaze for Chinese-red or ox-blood colour may be, a satisfactory lt will never be obtained if the firing is not directed in itable manner.

After the ware is glazed, either by dipping or spraying, has been set so that the smoke can reach it freely at a fire as oxidising as possible is maintained. As as a dark red heat shows in the kiln, as much smoke ossible is to be produced and continued up to a tem-ture at which the glaze commences to vitrify. This llowed by short periods of oxidising fire, kept up at t intervals, about one to two minutes for each quarter n hour; between these, however, a strongly reducing atmosphere must prevail. This mode of firing must continued until the glaze has become dense and some-t glossy. Thereupon the burning may proceed with ising or reducing kiln conditions up to the close of burn. This method of burning, however, will not be to carry out in ordinary coal furnaces, especially will t be possible, as a rule, to produce the oxidising fire for so short a time without maintaining between time ger or shorter period of neutral conditions. But in furnaces with inclined grates, fired with wood, one is *enabled to produce such a change almost instantaneously* by opening the air-passages beneath the charge of wood, and for this reason firing with wood will always remain *the most satisfactory way of firing for the reproduction of* red copper glazes, if for no other reason than that it, more than any other, permits of a uniform and intense *evolution of smoke*."

(To be continued).

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, March 11, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read:—

"*The Pressure upon the Poles of Metallic Arcs, including Alloys and Composite Arcs.*" By W. G. Duffield, T. H. Burnham, and A. A. Davis.

In a previous communication (*Phil. Trans.*, A, 1919 ccxx., 209) the authors showed that the poles of a carbon arc behaved as though they repelled one another, and methods were described by which the pressure upon each pole could be measured. Reasons were given for attributing this effect to the reaction consequent upon the emission of electrons from the poles under the influence of thermionic or photo-electric action.

The present experiments relate to arcs between iron copper, and silver terminals, the rate of variation of the pressure with current density being measured for the anodes and cathodes. The pressures were greater than in the carbon arc, that within the copper arc being the largest. Assuming that the pressure is due to the projection of electrons, a comparison between the kinetic energy of the electron and of the metallic atom at the temperature of the poles showed sufficient agreement to suggest that the electrons before projection were in thermal equilibrium with the metal of the pole.

The reactions upon electrodes composed of an alloy of silver and copper were also measured, likewise those within an arc between a silver and a carbon pole. In this case the pressure was determined mainly by the material of the pole under examination.

The problem of the mechanism whereby a gas may be heated is briefly discussed. Some account is also given of the variation in the potential difference between the poles when the material of one is altered.

"*Further Experiments on the Variation of Wave-length of the Oscillations Generated by an Ionic Valve due to Changes in Filament Current.*" By J. H. Vincent.

Eccles and Vincent have found that in an oscillator circuit maintained by a thermionic valve with a grid coupling, the wave-length has a maximum value for certain filament current. This effect is studied further in this paper.

In order to vary the filament current, rheostats were designed and used, in which the change of resistance was unaccompanied by any sensible change in the self induction of the filament circuit.

The methods of measuring the change of wave-length due to the variation of filament current were different from that employed by Eccles and Vincent; but it was found that the results obtained were independent of the particular method by which the wave-length was studied.

It is suggested that changes in several of the variables of a valve-maintained circuit produce effects of the same sign on the wave-length and the amplitude of the oscillations.

The wave-length and amplitude decrease with the decrease of the grid voltage or of the plate voltage. The

also decrease when the coupling of the grid coil with the main oscillator coil decreases.

Increasing the resistance in either the condenser branch or the inductance branch of the main oscillating circuit lessens the amplitude and wave-length, while altering the filament current in either direction from that giving the maximum wave-length gives also a decreased amplitude.

"*The Theory of the Katharometer.*" By H. A. Daynes.

A historical introductory note by G. A. Shakespear, M.A., D.Sc., gives a description of the katharometer, and an account of its development by him for hydrogen purity measurements and similar work in connection with lighter-than-air craft.

The paper discusses the conditions which determine the temperature of the hot wire in the katharometer cell, and shows that loss of heat by conduction through the gas is the most important factor, convection and radiation being quite unimportant.

Equations are given expressing the experimental law of heat loss in a single katharometer wire, and these are applied to the case of two wires in parallel in the arms of a Wheatstone bridge.

These equations are then used to show what are the conditions for greatest sensitiveness and precision in various cases arising in practice.

"*The Process of Diffusion through a Rubber Membrane.*" By H. A. Daynes.

The nature of diffusion of gases through rubber membranes is discussed in the light of some recent work. This all points to a simple process, determined by the case of diffusion through the rubber, and by the absorption of the gas by the rubber.

This is introduced mathematically into the problem of diffusion through a membrane. The unsteady state is considered, in which the membrane, after being exposed to air, is suddenly exposed on one side to, say, hydrogen, and the rate of emission of hydrogen from the other side is calculated. The passage of gas through the material is treated purely as a diffusion problem, the boundary conditions only being determined by absorption.

It is shown that measurements of the permeability of a membrane and of the lag on reaching a steady state are sufficient for the determination of both absorption and diffusion constants.

Experiments are described in which these conditions are fulfilled. The measurements of the diffusion are made by means of a katharometer. From these experiments the constants of diffusion and absorption for hydrogen, nitrogen, oxygen, carbon dioxide, nitrous oxide, and ammonia are determined. Temperature coefficients for the constants are given for hydrogen, and the high temperature coefficient of permeability of rubber is shown to be due chiefly to the high temperature coefficient of the diffusion constant.

The extraordinary high permeability of rubber to carbon dioxide, ammonia, &c., is shown to be entirely due to the high absorption. A relation is also suggested between absorption and critical temperature of the gas.

## PHYSICAL SOCIETY.

*Ordinary Meeting, March 12, 1920.*

Prof. W. H. Bragg, F.R.S., President, in the Chair.

A paper on "*Absorption of Gases in the Electric Discharge Tube*" was read by Mr. F. H. Newman.

The paper describes a method of showing that absorption of nitrogen takes place in the discharge tube when sodium and potassium are used as the electrodes. The amount of gas absorbed for different quantities of electricity passing in the circuit is measured, and is less than that absorbed by the sodium potassium alloy. It shows also that when the alloy is used the amount of gas absorbed increases with temperature.

Discussion.

Dr. Beattie referred to the bearing of the phen on photo-electric cells. He asked if it was possi get such complete absorption as to give an X-ray va or if there was a dissociation pressure of the g equilibrium with the metal. The fact that the absorbed more than either metal separately was poss surface tension phenomenon. If a compound was f of which the surface tension was greater than that alloy, it would be drawn inwards, leaving a fresh s of the uncontaminated alloy in contact with the gas had found that when a discharge passed in v between iron electrodes a good deal of hydroge emitted. If the discharge was stopped this wa absorbed, although had the discharge been continue emission would have gone on as before.

Prof. Fortescue said the phenomena was probab result of several different effects. For instance, volatilised films had not been at atmospheric pre after volatilisation, the fact that they absorbed whi non-volatilised metals did not might be accounted f the latter having retained gas previously absorbed exposed to the atmosphere, while the former presen fresh uncontaminated surface. It was further po that the thickness of the sodium and potassium affected the results. As regards the anode and ca effects, will this not depend on the relation betwee numbers of positive and negative ions present? author says there is no time effect. Does he mean b that the absorption will go on, say, for fifty or sixty at a constant rate?

Mr. F. J. Harlow pointed out that the films of so and potassium were redistilled on silver. Might ther be alloys formed under these circumstances, the alloy not the metals themselves, possessing the abso powers? Had the author used a line cathode? this it was possible to get a very steady discharge fro lighting voltage.

Mr. B. P. Dudding thought we were here dealing problems which Langmuir and others had worked o some length. Some recent work of Dr. Norman Cam showed that, with suitable discharge conditions, pounds of almost any two elements could be for The essential thing was to remove the products o reaction in some way so as to keep a clean surface.

Mr. Newman, in reply, said that it was not possib get a very high vacuum with hydrogen. Although it absorbed by the alloy it was impossible to get rid o last traces. The surface of the alloy must be very c When the discharge is in nitrogen, the surface keeps c the scum formed breaking up and going to the of the tube, but with hydrogen a black scum which requires to be mechanically removed by shakin tube. As regards the constancy of the rate of absorp he could not give actual figures, but the rate certainl not diminish for a very long time. He agreed th would be difficult to prove that the sodium and potas films had not alloyed with the silver. He had not tr lime cathode, but had got very steady discharges by u the type of Wehnelt interrupter, which he had rec shown to the Society.

A paper on "*A Directional Hot-wire Anemometer*" read by Mr. J. S. G. Thomas.

The instrument consists of two fine platinum mounted close together, and forming two of the arm a Wheatstone bridge. These are heated by the curre the bridge. When a stream of gas moves in a direc perpendicular to the wires but parallel to the plane taining them, the leading wire is cooled, while the sec wire, being shielded by the first, is not cooled so m and may actually be heated on account of the air flo past it being warmed by the first wire. A deflectio the galvanometer is obtained, therefore, which is reve if the flow of gas is in the reverse direction. The in ment is much more sensitive than the non-directional wire anemometer.

DISCUSSION.

Mr. EZER GRIFFITHS said he had been working with hot-wire anemometers recently, but they required somewhat complicated gear. It is assumed in working out the theory that the flow of gas is parallel to the axis of the tube. What happens if this is not so owing to the proximity of bends?

Mr. TUCKER said he had used a hot-wire anemometer for impulsive and alternating flows. But the hot-wire inevitably produces its own direct current due to convection. He had found the curious result that the sensitivity to alternating currents could be increased many times by increasing the strength of the direct current to which the wire was exposed. Had the author attempted to increase the sensitivity by reducing the diameter of the wires? The sensitivity rose very rapidly as the diameter was reduced.

Dr. E. H. RAYNER asked if experiments had been made with different dimensions to see if the range of usefulness could be increased. He thought the velocities in gas mains would usually be much greater than 4 cm. per second, which seemed to be about the maximum useful range with the present instrument.

Mr. F. E. SMITH said he was not convinced by the author's explanation of the first wire being further cooled, due to the proximity of the second hotter wire. He suggested a simple experiment to prove whether or not this cooling actually took place.

Dr. BORNS asked if all the experiments had been in coal gas.

Prof. RANKINE asked if any difficulties arose due to the wires not remaining in the plane parallel to the flow. One would expect sagging to occur, and the two wires would not necessarily bulge in the same direction.

Dr. D. OWEN suggested that there might be some advantage in this respect if grids were used instead of wires.

Dr. L. HOPWOOD said the author was to be congratulated in finding a directional instrument which was more sensitive than a non-directional one. Direct measurements could be made on the convection current effects by using a vertical flow. In one direction the convection currents would assist the flow, and in the other would be against it.

Dr. T. BARRATT (communicated)—I have read Mr. Thomas's interesting paper with much pleasure. His explanations of the more or less intricate phenomena involved are convincing and simple. In one particular, however, the facts can be explained more simply as well as more accurately. Radiation from thin wires, even at moderately high temperatures forms a very small percentage of the total heat lost. In the case of Mr. Thomas's anemometer wires this percentage is probably less than 5, and certainly less than 10 if the wire is "bare"—*i.e.*, slightly soiled by exposure to air, &c. That is to say, nearly all the lost is lost by convection. An explanation of the observed facts can be made, however, without any assumption of radiation at all. Assuming that nearly all the loss of heat is due to convection, "free" or "forced," the air reaching *b* from the direction of *a* is considerably warmer than the rest of the gas. Hence the convection from *b* (which strictly obeys Newton's first power law) is considerably reduced, resulting in a higher temperature for the wire *b*. At higher velocities of the cooling fluid the air from *a* reaching *b* is not so warm, so that *b* is cooled more than at low velocities. The remaining explanations can follow on the same line of reasoning.

The AUTHOR, in reply, said that as regards disturbed stream lines, King's investigations showed that the turbulent condition could be better investigated with hot-wire anemometers than by other types. In the gas works the instruments are fitted far from bends. One important point was that owing to the proximity of the wires the zero reading is much more constant than with the ordinary non-directional type. With regard to the points about convection currents mentioned by Messrs. Tucker and Hopwood, experiments had been made with vertical currents. He had tried the experiment suggested by Mr. F. E. Smith, and had verified the fall of temperature. He had used currents of air, carbon dioxide, oxygen, hydrogen, and other gases. With hydrogen, methane, &c., the instrument with bare wires cannot be used at all, but the wires can be coated with glass without reducing the sensitiveness. It is this type that is used in the works. The wires getting out of line was certainly a difficulty, but he was getting over this by mounting them in such a way that they would always be kept taut. If time permitted he would try a grid arrangement as suggested by Dr. Owen. In reply to Dr. Rayner, he was attempting to develop the instrument for higher velocities.

Dr. HANS PETTERSSON exhibited and described a new Microbalance.

This instrument, which is sensitive to a few millionths of a mgrm. is constructed entirely of quartz. Its special feature is that no knife edge is employed, the beam being suspended by two very fine quartz fibres.

The exhibitor gave an account of some interesting physical problems, which the instrument was being employed or about to be employed to solve.

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## MINERALOGICAL SOCIETY.

*March* 16, 1920.

Sir WILLIAM P. BEALE, Bart., President, in the Chair.

"*Occurrence of Cotunnite, Anglesite, Leadhillite, and Galena on Fused Lead from the Wreck of the Fire ship* Firebrand, *Falmouth Harbour, Cornwall.*" By ARTHUR RUSSELL.

The specimens were obtained in 1846 from the wreck of the Fire-ship *Firebrand* which was burnt in Falmouth Harbour about the year 1780. They were found under the lead pump, most of which appeared to have been melted and mixed with charcoal, and consist of slag-like masses of lead, which has evidently been fused, and upon the surface and interstices of which are numerous well-defined and brilliant crystals of cotunnite and anglesite, and more rarely small crystals of leadhillite and galena. The cotunnite crystals, which are colourless and transparent, with brilliant faces, are nearly always elongated in the direction of the axis, and attain a length of 3 mm. The habit is somewhat variable owing to the very unequal development of the faces. The forms observed were 010, 001, 021, 011, 012, 101, 111, 112. The anglesite crystals are of rectangular habit, and exhibit the forms 100, 001, 110, 102, 122, and 113. The leadhillite crystals, thin six-sided plates in shape, are of a brown colour, and show the forms 101, 201, $\bar{1}01$, $\bar{2}01$, 112, 111, $\bar{1}12$, $\bar{1}11$. The galena occurs in minute cubo-octahedra. An occurrence of cotunnite formed under exactly similar conditions has been described by A. Lacroix. Similar occurrences of lead oxychlorides at Laurium and of leadhillite in Roman slags from the Mendip Hills were referred to.

"*Riebeckite-rhyolite from North Kordofan, Sudan.*" By W. CAMPBELL SMITH.

A rock found by Dr. G. C. Seligman at the base of Jebel Katul, 350 miles S.W. of the Bayuda volcanic field, was described.

"*The Meteoric Iron of Mt. Ayliff, Griqualand East, S Africa.*" By Dr. G. T. PRIOR.

This meteoric iron, found about 1907, is a coarse octahedrite similar in character to Wichita County (Brazos River) and Magura (Arva). On polished and etched surfaces it shows nodules of graphite and troilite, and abundant cohenite crystals arranged parallel to the octahedral bands. It contains about 7 per cent of nickel

## NOTICES OF BOOKS

*The Chemistry of Colloids.* Part I. "Kolloid-Chemie." By R. ZSIGMONDY; translated by E. B. SPEAR. Part II. "Industrial Colloidal Chemistry." By E. B. SPEAR, S.B., Ph.D. And a chapter on "Colloidal Chemistry and Sanitation," by J. F. NORTON. London: Chapman and Hall, Ltd. 1917. Price 13s. 6d. net.

THE science of colloidal chemistry has made rapid strides during the last few years; in fact, this branch of chemistry is not sixty years old. When one reads the book under question one can realise the amount of patience, time, and thought that has been given to this subject.

There is no doubt that colloidal chemistry plays a very important part in many reactions, hitherto unexplained or given an incorrect explanation. As an example of this, Berzelius contended that purple of cassius was a chemical combination, forming a hydrated double stannate of gold and tin. Zsigmondy, in his book, says that the purple will not pass through parchment paper during electrolysis as electrolytes do; its methods of preparation and other properties which the purple possesses goes to show that the gold has not entered into chemical combination, although the reactions have so materially changed, and he says that a mixture of colloidal gold and colloidal stannic acid in correct proportions treated with dilute acids gives a precipitate that is identical in every way with purple solutions made according to the usual methods.

Zsigmondy's work as translated by Dr. Spear is welcome, for colloidal chemistry is a subject which is not overburdened with text-books. Dr. Spear is to be commended on his admirable translation.

Zsigmondy commences his treatise with a chapter of definitions and general considerations, giving the reader a thorough insight to colloidal chemistry. The author, at the end of this chapter, gives a diagrammatic sketch of the relative sizes of a hydrogen molecule and a corpuscle in the human blood.

The next three chapters deal with the theoretical aspect of colloids. From Chapter V. to the end of the first part is a series of chapters on definite instances of colloidal substances, arranged in classes, such as inorganic colloids, organic colloids, colloidal oxides, dyestuffs, protein bodies, &c. Zsigmondy gives explanations to these reactions with his substantiations which, as our knowledge of colloidal chemistry advances, may be found faulty, but make the book attractive.

Part II. is termed "Industrial Colloidal Chemistry," the author of which is the translator of the above. He deals with colloidal chemistry as it affects the technical chemist. Among the subjects which he discusses are:—Rubber, including vulcanisation and its theories, tanning, milk, clays, and soils. The final chapter deals with colloidal chemistry as regards sanitation, written by Dr. John Foote Norton, S.B., Ph.D. This second part takes up only thirty-four pages of the book, whilst some of the subjects under discussion are dismissed in a page. This makes this portion very brief, which is a pity, especially in dealing with such important technical substances; otherwise the book can be recommended as an authority on colloidal chemistry.

### BOOKS RECEIVED.

"Chemistry of Coal." By J. B. ROBERTSON, M.A., B.Sc., A.I.C. Pp. viii+96. 1919. London: Gurney and Jackson, 33, Paternoster Row, E.C., Price 3s. 6d. net.

"Theoretical and Applied Colloid Chemistry." By Dr. Wo. OSTWALD. Translated by Dr. M. H. FISCHER. Pp. xv+232. 1917. London: Chapman and Hall Ltd.

"Bismuth, Etain, Plomb." By A. BOUCHON vi+375+xii. 1920. Paris: O. Doin et fil de l'Odéon. Price 7 fr. 50.

"The Dyeing Industry." By S. H. HIGGI Pp. viii+189. 1919. London: Longmans, C Co., 39, Paternoster Row, E.C. 4. Price 8

"Limes and Cements." By E. A. DANCASTE A.I.C. Pp. xii+220. 1920. London Lockwood and Son, 7, Stationers Hall Cou

## NOTES.

EXPORT PRICE REGULATIONS IN GERMANY been brought to the notice of the Department of Trade that owing to the refusal of the authorities to grant export licences for good in Germany unless the purchase price is calc special rates fixed for the foreign market by Control Office concerned, British traders who l money in advance for goods bought at a price ag the German seller, are unable to obtain deliver goods without an additional payment. British p would, therefore, be well advised, before ma advance payment wherever possible to insist on t the German seller has already obtained the export licence, and consequently that the prices the German seller are in accordance with the spe fixed by the Price Control Office concerned.

INDUSTRIAL LEAGUE AND COUNCIL.—The Ma of the Industrial League and Council *Journal*, w just come to hand, contains a particularly in account of the work of the Joint Industrial Coun Printing Industry. In view of the fact that lit official information is obtainable as to the success wise of the operations of Joint Industrial Cou information this article conveys should be of i interest to those trades which are yet hangin balance on the question of agitating for the estal of a Whitley Council. The Printing Industr doubtedly as complex as any other industry c within the United Kingdom. While it is a highly organised, the fact must not be overlook embraces workers from no less than 23 trade un if it is possible to bring these within the scope o Industrial Council, there is surely no logical rea every trade in the country cannot be similarly o The report therefore provides very instructive rea very significant indeed is the admission that Industrial Council has been instrumental in prod only harmony in the trade but good and beneficia to all engaged in it. To quote one extract—"Wh Joint Industrial Council done? . . . It is signif throughout the most difficult period of the past there has been no serious disturbance in the printi such as we have witnessed in other industries." no greater testimonial of the efficiency of the Council movement can be adduced, and it is inter note that the Industrial League and Council pla forefront of their activities propaganda to crea relations between employers and employed, by th tion of Whitley Councils in respect of all trade League *Journal* also contains a splendid accou George Paish of the financial situation in Europe about by the war, and many other interestin dealing with scientific management; also a luci of industrial statistics by that brilliant young sta Mr. H. G. Williams, which is a monthly featu *Journal*, and a report of the activities of the L Portsmouth, Birmingham, Leeds, and other p areas.

# CHEMICAL NEWS

VOL. CXX., No. 3130.


## TERRELATIONSHIP OF THE CHEMICAL ELEMENTS.

By HAWKSWORTH COLLINS.

llowing demonstration of the interrelationship of ical elements the experimental data upon which overy is founded are first given; three sets of *nces in these facts are then noted, each set being to be due to some cause and not to chance, and he truths, which have caused the coincidences to ved, are discussed.*

I. gives all the pairs of elements, the sum of tomic weights approximate to the atomic weight *dium. The roman figures denote the maximum* of each element.

s II. and III. contain experimental data with *to chromium and manganese corresponding to* Table I.

TABLE I.

| | | | | | | | O = 16. | H = 1. |
|---|---|---|---|---|---|---|---|---|
| adium$^{V}$ .. | .. | Atomic weight | | | | | 51·0 | |

*Sum of Atomic Weights.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| + Al$^{III}$ | .. | 24·32 | + | 27·1 | = | 51·42 | 51·01 |
| + S.$^{IV}$ | .. | 23 | + | 28·3 | = | 51·3 | 50·89 |
| + P$^{V}$ | .. | 20·2 | + | 31·04 | = | 51·24 | 50·83 |
| + K$^{I}$ | .. | 12 | + | 39·1 | = | 51·1 | 50·69 |
| + Ca$^{II}$ | .. | 11 | + | 40·07 | = | 51·07 | 50·66 |
| + Sc$^{IV}$ | .. | 6·94 | + | 44·1 | = | 51·04 | 50·63 |
| + A | .. | 11 | + | 39·9 | = | 50·9 | 50·49 |
| I | .. | 32·07 | + | 19 | = | 51·07 | 50·66 |
| + II | .. | 35·46 | + | 16 | = | 51·46 | 51·05 |

TABLE II.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| romium$^{VI}$ . | .. | Atomic weight | | | | 52·0 | |
| + S$^{IV}$ | .. | 24·32 | + | 28·3 | = | 52·62 | 52·21 |
| + S$^{VI}$ | .. | 20·2 | + | 32·07 | = | 52·27 | 51·86 |
| + Ca$^{II}$ | .. | 12 | + | 40·07 | = | 52·07 | 51·66 |
| + V$^{V}$ | .. | 1·008 | + | 51 | = | 52·008 | 51·60 |
| + Ti$^{VI}$ | .. | 3·99 | + | 48·1 | = | 52·09 | 51·68 |
| + A° | .. | 12 | + | 39·9 | = | 51·9 | 51·49 |

TABLE III.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| anganese$^{VII}$ | .. | Atomic weight | | | | 54·93 | |
| + A$^{III}$ | .. | 28·3 | + | 27·1 | = | 55·4 | 54·96 |
| + P$^{V}$ | .. | 24·32 | + | 31·04 | = | 55·36 | 54·92 |
| + S$^{VI}$ | .. | 23 | + | 32·07 | = | 55·07 | 54·63 |
| + C.$^{VII}$ | .. | 20·32 | + | 35·46 | = | 55·66 | 55·22 |
| + S.$^{IV}$ | .. | 11 | + | 44·1 | = | 55·1 | 54·66 |
| + T.$^{VI}$ | .. | 6·94 | + | 48·1 | = | 55·04 | 54·6 |
| + V$^{V}$ | .. | 3·99 | + | 51 | = | 54·99 | 54·55 |
| + K$^{I}$ | .. | 16 | + | 39·1 | = | 55·1 | 54·66 |

ere are three *sets of coincidences* in these tables —(1) The sum of the valences of each pair is equal to the valency of the element under consideration in 17 cases out of 23. (2) The sum of the valences of each pair is an odd (or even) number according as the valency of the element under consideration is odd (or even). There are no exceptions. (3) The sum of each pair of atomic weights is greater than the integer which is nearest to the atomic weight of the element under consideration in 20 cases out of 23, when the atomic weight of oxygen is taken as 16, and is less than the same in 19 cases out of 23, when hydrogen is taken as the unit.

*Proof that the first set of coincidences is not due to a series of accidents:—*

The maximum valency of elements of atomic weight less than 56 may be 0, 1, 2, 3, 4, 5, 6, 7, and there is no tendency for preference towards any of these figures, for there are about as many elements of single valency as there are of double, triple, &c.

The sum of the valences of any two elements might be 0, 1, 2, 3, . . . 14; *i.e.*, 15 possibilities.

So the probability that the sum of the valences of any pair (chosen as above) would accidentally be equal to the valency of the element under consideration is 1 : 15, and the probability that the same would happen accidentally in all the 23 cases is $1 : 15^{23}$, with 6 exceptions.

$$1 : 15^{23 - \frac{6 \times 15}{14}} = \text{one to billions.}$$

Therefore the probability that this state of affairs is not due to a series of accidents is "billions to one."

*Proof that the second set of coincidences is not due to a series of accidents:—*

There are 23 cases to which there is no exception. Therefore the probability that this state of affairs is not due to a series of accidents is $2^{23} : 1$ = eight million to one.

*Proof that the third set of coincidences is not due to a series of accidents:—*

The probability that the sum of the atomic weights of any pair (chosen as above) would be above the integer which is nearest to the atomic weight of the element under consideration instead of below is 1 : 2, and the probability that the same would happen by accident in 20 cases out of 23 is $1 : 2^{23-6} = 1 : 2^{17}$.

Also the probability that the sum of the atomic weights of any pair (when hydrogen is taken as the unit) would be below the integer which is nearest to the atomic weight of the element under consideration instead of above is 1 : 2, and the probability that the same would happen by accident in 19 cases out of 23 is $1 : 2^{23-8} = 1 : 2^{15}$.

*Therefore the probability that the third coincidence,* as a whole, is not due to a series of accidents is $2^{17+15} : 1$ = 4000 million to 1.

Since these three sets of coincidences have now been proved to be due to causes and not to chance, it is possible to consider what the truths are which have caused the coincidences to be observed.

The first and second sets of coincidences are solely concerned with atomic weight and maximum valency. Therefore it is evident that there is a definite connection between mass and valency. The connection between the two has already been shown in the CHEMICAL NEWS (Dec. 26, 1919), and will be further demonstrated in the next paper. It is as follows:—

*Each one of a large number of elements is composed* of one or more portions of masses 1, 3, 7, 23, and 39, from each of which emanates one valence.

The third set of coincidences is solely concerned with atomic weight, and the truth which is the cause of their being observed can only be as follows.—

There is some unknown source of error, which causes *the atomic weights in general to be estimated as greater* than they really are; just as there was formerly (when H

was taken as the unit) some error, admitted by chemists, which caused the atomic weights in general to be estimated as less than they really are.

The reason for the alteration of atomic weights from a system founded upon a unit to the present system in which there is no unit (unless the sixteenth part of an atom of oxygen be called the unit) may be stated as follows:—Chemists found that when the atomic weight of oxygen was taken as 16 the atomic weights of several elements came nearer to whole numbers than previously. Therefore they must have considered that the present system contained within it the germ of an additional truth, which was quite invisible in the old system. In this respect it may be said that they considered that the present system was nearer to the truth than the old one, and therefore that the latter was less correct than the former.

Tables with regard to several other elements, similar to those given here, can be constructed, and the fact that there are some exceptions, *e.g.*, N and Zn, does not diminish the certainty of the matter at all, because there is no reason why all elements should be supposed to havebeen built up in the same uniform manner, although they may all be formed from the same ultimate material.

Although these three elements, V, Cr, and Mn, have been arbitrarily chosen out of the 83 recognised elements, it is quite correct to reason upon the facts concerning them independently of those concerning other elements, as long as the coincidences with regard to them can be shown to be so extraordinary as to be altogether removed from the possibility of chance. And no exceptions, however numerous, that may be observed with regard to other elements can affect the matter in the slightest.

This discovery, which is called "the Interrelationship of the Chemical Elements," is a much larger generalisation than the Periodic Observation; it is much fuller in detail than the latter, and leads to definite conclusions with regard to the constitution and structure of nearly all the elements. The facts given in these three tables are of a far more concordant nature than the facts which are accepted by chemists as illustrating conclusively the existence of certain approximate regularities, which are sometimes called "laws," although there may be numerous exceptions to the general rules observed; *e.g.*, the facts which led to the enunciation of the law of Dulong and Petit vary by as much as 13 per cent, whilst the data which led Kopp to declare that he had discovered the relative volume of the group $CH_2$ at the boiling point to be about 22 can only be described as execrable, and his deductions therefrom of the relative volumes of C and H do not happen to be anywhere near the truth.

A definite reason for the apparent inapplication of this interrelationship to the cases of some elements of high atomic weight will be given and demonstrated in a later paper.

It is necessary to notice that there is no hypothesis or guesswork in any part of this investigation, and that it is of an entirely different nature from attempts, which are frequently made, to put together a few selected scientific data in such a way that they appear to support some preconceived idea. All experimental facts available, whether favourable or unfavourable, are employed in this demonstration, and there is no arbitrary choice of figures what-

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of the exceptions to the first coincidence afford
·s of the difference of the valences of pairs being
the valency of the element under consideration
BC the sum, a state of affairs which frequently
Chemistry of Co ...e significance f this consists in the fact that
B.Sc., A.I.C. ...) in the Chemical News, Feb. 28, 1913, that
Gurney and Ja... quiescent in pairs, so that if Cl and O, *e.g.*,
Price 3s. 6d. net... not by valences) in order to form one element,
... form an element like V, if one pair of valences
Theoretical and ...escent; whereas the same result would happen
Wo. Ostwald. ...of the union of Mg and Al, *e.g.*, without any
Pp. xv+232. 191... ...ing quiescent.
Ltd.

POSITIVE RAYS.

An account is given in a recent issue of ... (March 26, p. 402) of Prof. Sir J. J. Thomso... one lecture on the above subject at the Royal ... Vacuum-tube discharges, involving the pr... electrons, atoms, and molecules, have been turn... account by Prof. Thomson, his method of a... apparatus being now well known, but a few w... troduction will serve a useful purpose.

Atoms and molecules when positively and ... charged (more frequently of the former charge) ... ling at a high speed (about 2000 miles per ... deflected by superposed magnetic and electros... A photographic plate is arranged in Prof. ... apparatus to register the landing or striking ... these deflected masses, which position varies a... (1) the magnitude of the charge carried by ... particle (*i.e.*, whether 1, 2, 3, 4, 5, 6, 7, or 8; ... be the limit; numbers above 1 are always positi... the mass of the particle itself, and it is a simpl... calculation to determine the mass of the atom... cules, as the case may be, by taking into a... place of impact on the plate and the forces act... moving particles which cause their deflection. ... mass value and charge the striking spot is a ... forming generally a part of a parabola, the pt... plate revealing such lines of impact. In some ... plete parabolas are recorded on the plate.

Helium present in 1 cc. of air is detecta... method. It is extraordinarily sensitive, so tha... gases present, either in the vacuum tube itself ... by the bombardment of substances by the cat... are profusely registered on the plate. This p... does not mean that comparatively pure substanc... a very appreciable amount of impurity in a rela... yet in certain cases relatively abnormal amounts... and a gas of atomic or molecular mass of 3 ... recorded. It is extremely doubtful whether ... sufficient amount of these two substances prese... rant the assumption that the bombardment i... freeing atoms of sub-atomic origin, yet this poss... seriously to be considered. A new substance ... its appearance which has an apparent molecular ... mass of $3\frac{1}{2}$ or 7.

Acknowledging the above-mentioned source c... tion the following should be of interest to read... Chemical News.

The speed of the positive rays is about 2000 ... second which is roughly a speed midway betwe... α-rays (helium atoms ejected by radio-active c... radium, which are ten times this speed, and th... of ordinary gas molecules.

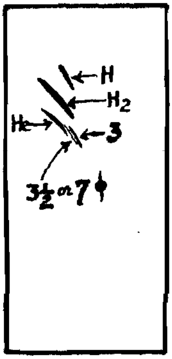
Goldsmith (see paper in *Phys. Rev.*, 1913) i... the penetrating power of positive rays was tl... interpose sheets of mica in the ray-path, and t... menter found that a sheet 1/200 mm. thick ... penetrated, the missiles in this case being hydro... or molecules. The rays were deflected by mag... electric fields. Another experimenter also def... positive rays in the same manner, and using as ... phosphorescent screen covered with thin gold ... parabolas were visible when H, $H_2$, and N or O ... employed. The particles after emerging from ... leaf had lost their charge. Gold leaf that would ... hydrogen, moving with a velocity $2 \cdot 8 \times 10^8$ cm. p... (about 2000 miles per second), had a thic... $3 \cdot 6 \times 10^{-6}$ cm.

The spluttering of the negative electrode in th... tube, by the impinging positive rays, causes the ... the tube to be coated with a metallic film. Th... has been made use of to get thin deposits on glass ... both transmit and reflect light. Muslin placed ... cathode has been coated with the volatilised m... both gold and silver lace have been produced ... method.

is dependent upon the cathode fall of potential
:ds a definite value and the nature of the gas
Denser gases generally enhance this effect.
splutters badly in argon, but with air or
the tube aluminium does not act in this
:pt to a very slight extent, under comparable

tances other than metals can be "spluttered,"
; that is to say, disintegrated by the positive

ibes provided with a curved cathode to focus
naterials, placed on a support or table within
in a sense electric furnaces, as substances
d to very high temperatures by this method.
may be broken up in this apparatus and the
ut liberated, and by means of an auxiliary
furnace products can be admitted for analysis
tion method.
ig potassium iodide in this way with cathode
substance of apparent atomic mass 3. In
:e of bombarding substances a parabolic line,




·The 3- and 3½-lines are drawn sharp or narrow in
sentation, and lower down than they occur on the
late.

very faint and apparently never strong but
appears which corresponds with a particle of

ppears to be considerable evidence that this
of mass 3 is tri-atomic hydrogen, but there is
ce that it is more elemental in nature or origin,
n Prof. Thomson's remarks. This problem of
ture of this substance has been under investi-
some time. Vapour of phosphonium iodide
line distinctly, though the line is not so strong
tain minerals. When ammonia was tested in
ay only traces of the 3-line were visible.
ng for months with a tube containing hydrogen
plate had the 3-line on it. Bombarding mica
oduced this line strongly. Certain conditions
ssary for its formation, and Prof. Thomson
the opinion that the line is due to $H_3$, as
understood, but some of this gas may be
al origin. Once this line appears it is very
and a good deal of "washing out" of the tube
one to remove it.
was often liberated at first when bombarding
howing that this gas was stored up to a small
extent in all solids. Unlike "3," however, it was gradually driven off, and entirely disappeared when the bombardment was long continued.

Another line has been noticed on the plates which was made prominent by bombarding non-crystalline fluor-spar. This mineral was found amongst the cryolite deposits at Ivigtut in S. Greenland, and contains traces of cerium. It was noticed by Julius Thomsen, but it has not been named. When this substance is bombarded in the focus tube an immense amount of helium is evolved. Between the helium line (4) and the hydrogen molecule line (2) a line representing an apparent mass of 3·5 appears. This strange line seems always to accompany the 3-line when obtained from minerals, but is of more feeble intensity. The 3·5-line was never present when the 3-line was absent. Lithium taken as 7 and carrying two positive charges would account for this line, but a lithium line carrying one charge was a doubtful or rare member of the positive-ray family of lines. Nitrogen with four charges would account for it, but it seems hardly pronounced enough or common enough to be due to nitrogen. Seven atoms of hydrogen acting as a transient molecule with two charges would give such a line, but this evaluation is too uncertain to be considered seriously. Examining the half-tone blocks given in *Engineering*, though very good, do not show perceptibly the 3½-line, whereas the $H_2$-line is perhaps 100 times stronger than the 3-line. The H-line is also very strong. The 4-line (helium), though not so strong as the H- or $H_2$ line, is narrower. I append a diagram giving those lines on the plate obtained when bombarding the fluor-spar, the 3½ line being shown stronger than on the original plate, judging from the absence of this line and the 3-line on this particular block.

F. H. L.

## THE STRUCTURE OF ATOMS.*

By Prof. A. BERTHOUD.

THE idea of an indivisible atom and an undecomposable chemical element, introduced into chemical science by Dalton, has been intimately bound up with the wonderful development of theoretical chemistry during the course of the last century. Even to-day it suffices for the interpretation of most purely chemical phenomena, in which the atoms behave as indivisible entities.

As long as we could entertain this idea rigorously, no problem of atomic constitution arose. Nevertheless, it gradually became evident that the Daltonian conception was not of sufficiently elastic character. This was shown by various phenomena, of which especial mention may be made of the relations between the properties of the elements and their atomic weights, as expressed in the periodic classification developed by Mendeleeff. These relations would be incomprehensible if each atom were an indivisible whole; if the elements were unconvertible one to another and different in their very substance. They become conceivable only if we suppose that the atoms are not simple, but represent more or less complex systems between which there exist certain structural similarities.

Although the conception of the atom had thus become modified, any precise hypothesis as to the constitution of matter remained long impossible for want of an experimental basis. No method capable of revealing the mysteries of atomic structure appeared to be available, and further study of the problem seemed to be relegated to some period in the distant future.

Nevertheless, and much sooner than we could have dared hope for twenty or thirty years ago, certain unexpected discoveries have now allowed us to attack the problem with success. It was the discovery of the

* Address to the Société Helvétique des Sciences Naturelles, September 7, 1919, at Lugano. From the *Revue Générale des Sciences pures et Appliquées*, October 30, 1919.

Röntgen rays (in 1895), followed soon after by that of radio-activity, which opened up a new era for the question of the constitution of matter. A definite connection between atomic structure and X-rays was not, indeed, disclosed forthwith; but the researches to which those rays gave rise have at length led to a discovery of the first importance in respect of the atom, namely, that of the *electron*.

This is the name bestowed upon a minute particle, carrying a negative charge of electricity, which is given off from matter under diverse conditions. Its electric charge is the smallest known. It is the elementary charge of electricity, and every quantity of electricity is a multiple of this elementary charge. The dimensions of the electron are incomparably smaller than those of the atom. Compared with an atom denoted by a sphere of 10 metres diameter, the electron is but a microscopic particle of which the diameter does not exceed 0·1 mm.

The mass of the electron is 1830 times smaller than that of the lightest atom, namely, that of hydrogen, and it is necessary to emphasise an extremely important character of this electronic mass.

It is a well known fact that electricity possesses a property which is ordinarily considered as a characteristic attribute of matter, namely, inertia or mass. To this inertia of electricity are due the familiar phenomena of self-induction. A charged particle possesses, therefore, in virtue of its charge, a certain inertia, a certain mass. Now it is almost sure that the entire mass of the electron has no other origin than this; that is to say, it is due solely to its electric charge. Thus the electron appears as a corpuscle of electricity, devoid of any basis of matter in the ordinary sense of the word. It is at one and the same time both the elementary particle of negative electricity and an elementary particle of matter.

Various optical and magnetic phenomena, and the fact that all matter is capable of emitting electrons under different conditions, indicate that the electron is a constituent element of all bodies. Thus we are led to the electric conception of matter, according to which every substance is formed of an agglomeration of particles of electricity.

Obviously matter, which is electrically neutral, cannot consist solely of negative electrons. The charges of these must be neutralised by equal quantities of electricity of opposite sign. Hence the existence of the negative electron implies that of the positive electron. But despite assiduous search positive electricity has never been found connected with any mass smaller than that of an atom.

Turning now to the phenomena of radio-activity, it is a matter of common knowledge that a radio-active element is unstable, and undergoes spontaneous transformation with emission either of $\beta$-rays, consisting of electrons travelling with a velocity sometimes approximating to that of light, or of $\alpha$-particles consisting of helium atoms and carrying two elementary charges of positive electricity.

Radio-activity therefore shows us a veritable transmutation of elements, and realises in a very unexpected manner the dreams of the alchemists. It gives us direct and tangible proof of atomic complexity, and shows that, side by side with the electron, but playing doubtless a very different *rôle*, the $\alpha$-particle also is one of the stones which help to build up the atomic edifice.

The study of radio-activity has revealed the existence of numerous elements which nothing had previously indicated, and naturally the question of finding them a place in the periodic system has arisen. No difficulty was found as regards some of the earlier discovered members (radium, polonium); but as the number grew it soon became evident that they could not all be accommodated without enlarging the scope of the system. The number of disposable places in the region which corresponds with their atomic weights, all included between 206 and 238, is manifestly insufficient.

(NOTE.—At present about forty radio-active elements
are known in the uranium, thorium, and actiniun
The atomic weights have only been directly detern
a very few instances; for others they can be read
culated. Thus radium G, produced from radium
loss of five $\alpha$-particles (He = 4), will have an
weight equal to that of radium (226) diminished b
and therefore = 206).

However, investigations of the chemical prope
radio-active elements have brought to light a fac
was absolutely unexpected. Notwithstanding th
ferent atomic weights certain elements show a co
agreement in their chemical properties; an agreen
perfect that when these elements have once been
is not possible to separate them again by chemical
The first instance of this was noted by Boltwoo
twelve years ago in the case of thorium and
thorium, and since then the number of analogous ex
has increased so much that it would be ted
enumerate them. This is the phenomenon of
Now it is clear that two elements chemically id
must occupy the same position in the periodic
Thus the small number of places at disposal
system is no longer an obstacle to the inclusion
radio-active elements.

The solution of this problem has been facilit
the discovery, due especially to Russell, Sodd
Fajans, of two laws called "laws of displace
which express a remarkable relation existing betw
nature of the emitted rays and the displacement
periodic system which an element undergoes as a
quence of radio-active transformation. (1) In every
formation where $\alpha$-rays are emitted the element
placed two steps in the sense of decreasing atomic
or, in other words, its atomic number decreases
units. (2) On the other hand, when $\beta$-rays are gi
the atomic number increases by one unit.

Thus $UX_1$, formed from U I by emission of an $\alpha$ p
has the same atomic number 90 as compared with 92
and $UX_2$, formed from $UX_1$ by the emission of a $\beta$-p
has the atomic number 91. The atomic numbers,
with that of hydrogen as unity, range through H
Li = 3, Be = 4, and so on, up to 92 for uranium; wi
a few gaps remaining as yet unfilled.

Hence it is that there are elements which are che
identical and have the same atomic number, al
their atomic weights are different—as, for in
radium B, radium D, and radium G, which al
the same atomic number 82, whilst their atomic
are respectively 214, 210, and 206. On the other
series of elements may have the same atomic wei
different properties and different atomic numbers.
$UX_1$, $UX_2$, and $U\pi$ have the atomic weight
common, whilst the respective atomic numbers are
and 92.

All the radio-active elements have now found the
in the periodic system. They form clusters or "ple
of isotopes, that of the lead group, for instance, con
of no fewer than seven elements, with atomic
ranging from 206 to 214.

The phenomenon of isotopy is not, however, lin
the radio-active elements.

There has long been good reason to believe that
term of the uranium series, radium G, is, in fac
But the atomic weight of this metal is 207·2, where
of radium G should be 206. It was therefore
conjectured that lead contained in uranium miners
derived at least in part from the disintegrat
uranium, would have an atomic weight lower than
ordinary lead. This expectation has been fully re
The values found have varied according to the na
the uraniferous mineral from which the lead was ex
but all have been lower than 207·2. The lowest
by Honigschmid, who started with a specially pure
mineral, is 206·0; this corresponds exactly with th
calculated for radium G. Moreover, this is not th
instance in which a direct proof has been given

[differ]ence of atomic weight does not necessarily carry with [it cha]nges of chemical properties.

[Th]e preparation in weighable quantities of isotopes [such] as lead and radium G has allowed researches of the [great]est interest to be undertaken as regards the similarity [of th]eir properties. Now neither in their chemical nor in [their] physical attributes has it been possible to discover [the s]lightest difference—not even in their luminous spectra, [which] ordinarily show fundamental changes as we pass [from] one element to another. The spectrum of radium G [is id]entical with that of common lead; that of ionium is [the s]ame as that of thorium.

[It] is to be noted that this identity refers especially to the [prop]erties of the atom. For example, water does not dis[solv]e equal weights, but equimolecular quantities of lead [nitra]te and the nitrate of radium G, and similarly it is not [the d]ensities or the specific volumes of lead and of radium [G w]hich have the same values, but the atomic volumes.

[T]here is no need to insist upon the importance of these [unex]pected results. If, among the fundamental principles [of t]heoretical chemistry, there was one which appeared to [be b]eyond doubt, it was that the properties of an element [dep]ended upon its atomic weight. And we find that this [prin]ciple is doubly in default. On the one hand, the [wei]ght of the atom varies, in many cases, without the [pro]perties of the atom being affected, and on the other [han]d elements of the same atomic weight may possess [diff]erent properties.

[H]ence it is not the atomic weight which determines the [pro]perties of an element, as has generally been held since [Me]ndeleeff's classification appeared. The properties [dep]end solely on the position of the element in the [per]iodic system—that is, on the number denoting its [ord]er in the series (1 to 92) its "atomic number."

This would be incomprehensible if the atomic number [we]re nothing but a simple ordinal number; it must [obv]iously have a deeper significance. Only if the number [cor]responds with something in the atomic edifice can we [con]ceive of its determining the properties of the atom.

Most of the properties are very complex functions of [the] atomic number. There is one, however, which [de]pends upon it in a simple manner, and is thus of con[sid]erable interest.

When an element, as anticathode, is subjected to a [ca]thode-ray bombardment of a sufficient velocity, it gives [off] X-rays of determinate wave-length and characteristic [of] the element in question. It has been found possible to [se]parate these rays by reflection from a crystal-face and [ph]otograph the spectrum. This "high-frequency" spectrum [is] much simpler than the ordinary luminous spectrum. It [co]ntains several series of lines, the two most important [be]ing the "K" series, comprising two lines $\alpha$ and $\beta$, and [th]e "L" series, which includes a variable number of lines.

The spectra of the different elements show a notable [an]alogy in this respect, namely, that the corresponding [lin]es of the same series—the $\alpha$ lines of the K series, for [ex]ample—have frequencies which are a very simple func[ti]on of the atomic number. Moseley has shown, in fact, [th]at the square roots of the frequencies are, to a first [a]pproximation, proportional to the atomic numbers (*Phil. Mag.*, 1913, xxvi., 1024; 1914, xxvii., 703). Constructing [a] graph with one of these quantities as ordinates and the [o]ther as abscissæ, a straight line is obtained for each series [o]f rays. The high-frequency spectrum is thus determined [s]imply by the atomic number, and, conversely, knowing [t]he spectrum for any element we can deduce the atomic [n]umber.

The systematic investigations carried out by Moseley, [a]nd then by Siegbahn and Stenström, Friman, de Broglie, &c., have thus allowed the atomic number to be [o]btained for all the known elements from sodium to [u]ranium (the noble gases excepted). These numbers are [a]ll comprised between 11 for sodium and 92 for uranium, [a]nd in all this series of whole numbers there are but six which do not correspond with known elements. It may [b]e inferred that between sodium and uranium six elements, and only six, remain to be discovered, namely, a metal of the alkali group (87), a halogen (85), probably both radio-active; two rare earth elements (61 and 72), and two homologues of manganese (43 and 75).

Isotopic elements, as might be expected, have exactly the same high-frequency spectra. This has been shown, especially for the isotopes lead and radium G, by Siegbahm and Stenström (*Comptes Rendus*, clxv., 428).

(To be continued).

## DEHYDRATION OF MILK.

Before the members of the Birmingham and Midland Section of the Society of Chemical Industry, at their meeting on March 25, at the University of Birmingham, Col. J. G. Wright, of Toronto, read a paper on "*The Dehydration of Milk*," in which he pointed to the great developments that have been made in the production of milk powder.

He prophesied that before ten years had elapsed we will be purchasing our domestic milk supply by the pound at the grocery store instead of having it delivered in liquid form. The success of condensed milk naturally, he said, encouraged chemists and inventors to devise some process by which the solids of the milk could be obtained in smaller bulk, but it was only in recent years that a commercially successful process had been brought out to extract only the solids of milk without the addition of foreign ingredients and capable of being reconstituted into a fluid more or less closely resembling the original milk. Two processes had been in general use since 1902, when considerable improvement was made. The product now obtained by several processes were sufficiently good to allow the preparation (by mixing the direct milk with water) of a fluid bearing a fairly close resemblance to fresh milk, or at least to heated or cooked milk. A great improvement had recently taken place as a result of a discovery by Dr. Dick, of Minneapolis, U.S.A., of what was known as the economic process, and it was now possible to ship 12 pounds of milk powder from Canada reconstructed by the addition of 88 pounds of water and do anything with that reconstructed milk that could be done with milk as it came from the cow. It could be used for ordinary domestic purposes, and the cream would rise, or it could be separated and butter or cheese could be made in the usual proportions.

Discussing methods, Col. Wright stated that in one process two hollow metal cylinders, arranged to revolve in opposite directions, are mounted so as almost to touch each other. The cylinder performs about 14 revolutions per minute. The cylinders are heated internally by steam so as to have a surface temperature of 100° C.; the milk is first evaporated *in vacuo* to about one quarter by volume; it is then pumped to the elevated containers over the cylinders and is allowed to flow between; the concentrated milk spreads in a thin film over the surface when the cylinders have completed one-half revolution, and the film of dried milk is scraped off and powdered in a powdering mill. In another process largely used in Canada the milk is evaporated *in vacuo*; then the evaporated milk is forced through fine needle points under pressure into a chamber containing hot air, when the powder falls to the bottom and does not require to be put through a powdering mill. Each of these processes requires a high degree of heat and occupies about one hour to complete. The new process which is to be used at St. Thomas Factory, Toronto, consists of two cells or chambers built of hollow tyle lined with tin. Each cell is 28 feet high by 21 feet square. At the top of the cell in the centre is the spray; it consists of two circular discs about 16 inches in diameter and placed one and one-quarter inches apart. Around the outer edge are placed a number of teeth. The sprayer was made to revolve by

a 5-horse power motor at 4500 revolutions per minute. The milk is fed in by gravity and sent out in a centrifugal spray, which is very finely divided. In the cell are 16 openings, four on each side to allow hot air to enter the cell. These openings are four feet long by five inches wide. The air is drawn from the outside through washers and passed over furnaces, driven by a 10 horse motor power fan. On the walls at the floor level are placed exhausts. The milk passes from the receiving station to the top of the first cell, and in passing through the latter 75 per cent of the water is removed. It falls and flows out at the bottom into a container as concentrated milk. From this container it is pumped up to a second cell, where the operation is completed; the balance of the water is extracted, and the milk flows to the bottom in powder, where it is caught by a fan and blown immediately into a cooling chamber on top of a sieve, through which it falls into a storage bin. Two cells have a capacity of 50,000 lbs. raw material each day, and were operated by three employees. The author pointed out that in the new process the milk never comes in contact with heat greater than 160° F., and the butter-fat globules are not broken up. Consequently the resulting powder will keep indefinitely. The process retains all the food elements of the original milk, and the reconstituted milk does not have a "cooked" taste. Col. Wright stated that butter of good quality had been made from milk powder which had been keep for two years. Dried milk is not germ proof, but the number of bacteria is small compared with the number in ordinary cows milk.

Samples of newly reconstituted milk were hand round for the examination of the chemists.

## PHTHALIC ANHYDRIDE.*

By H. D. GIBBS.

PHTHALIC ANHYDRIDE, a valuable intermediate for the manufacture of certain important dyes and medicinals, is usually made by the oxidation of naphthalene by means of sulphuric acid in the presence of mercury compounds as catalysts. This method is not as satisfactory as might be desired, since the yields are poor and erratic, generally averaging about 25 per cent theoretical, but occasionally running as high as 55 per cent.

It has been previously found that toluene vapours can be oxidised by passing a mixture of them with oxygen or air heated to a temperature varying from the boiling-point of toluene to 550° C. over oxides of the fifth and sixth groups of the periodic system, especially vanadium oxide and molybdenum oxide. Under these conditions the toluene is oxidised to benzaldehyde and benzoic acid, the former predominating. Similar reactions with (1) naphthalene vapours and air produce phthalic anhydride, with (2) anthracene and air, anthraquinone, and with (3) phenanthrene and air, phenanthraquinone. Since the demand for phthalic anhydride was acute, this problem was the first one thoroughly investigated.

The best laboratory yield was 82 per cent theoretical, or about 95 grms. of phthalic anhydride from 100 grms. of naphthalene. A small scale factory unit set up in the laboratory produced about 150 grms. of phthalic anhydride in one hour. A notable fact in regard to this method is the remarkable degree of purity of the phthalic anhydride.

The Department of Agriculture is co-operating with chemical manufacturers on this process, which, it is believed, once all the details are worked out, will be the most economical and practicable method known for making phthalic anhydride, and this compound may become one of the cheapest organic compounds.

* Abstract of a Paper published in Journ. Ind. Eng. Chem., 1919, xi., No. 11. Communicated by the Chief of the U.S. Bureau of Chemistry.

## TWENTY-THREE TYPES OF OPTICAL

By R. J. MONTGOMERY.

A DISTINCTION should be made between optical kinds of glass. By the word optical we mean tho which are selected for certain purposes becaus behaviour toward transmitted light. This bei primarily due to its composition and not to i Measurements of the index of refraction and classify the optical glasses into sub-divisions. In glass the composition may be changed to obt factory melting qualities, but in optical glass eac in composition will change the optical proper this account optical glass is much more difficult as the optical properties must be held constant wi narrow limits.

One hundred or more optical glasses have be but practically all of them may be placed in 2 The ones in each group are quite similar in co and in method of manufacture. They may b graphically by plotting the index of refractio dispersion on co-ordinate paper. The index of may vary from about 1·45 to 1·96, while the d may vary from about 20·0 to 70·0. From the information it is easy to determine the fields each glass constituent is used in the largest amou therefore have the lead field, the barium field, lime field, the boric acid field, &c. Approximate tions are apparent and new glasses may be devel interpolation between the compositions of known g *Journal of the Franklin Institute*, clxxxviii., No.

## THE COLOURS OF COLLOIDS.†

By WILDER D. BANCROFT.

(Continued from p. 165).

STOKES ("Mathematical and Physical Papers, iv., 245) has discussed the properties of a certain glass coloured by copper in a very thin stratum face. "By transmission it cut off a great deal and was bluish. By reflection, especially when th less face was next the eye, it showed a redd visible in all directions and having the appea coming from a fine precipitate, though it was not by the microscope, at least with the power evidently came from a failure in an attempt to m of the ordinary red glasses coloured by suboxide o and the only question was as to the state in w copper was present. It could not be oxide, for the was too small to account for the blueness, and in glass became sensibly colourless in the outer fla blow-pipe. Analysis of the transmitted light by t showed a small band of absorption in the place of seen in those copper-red glasses which are not t and therefore a small portion of the copper was p the state of suboxide, *i.e.*, a silicate of that bas rest was doubtless present as metallic copper, aris over-reduction in the manufacture; and accordi blue colour, which would have been purer if the had been away, indicates the true colour of co transmitted light, quite in conformity with what seen in the case of gold. Hence in both metal the absorbing and the reflecting powers are, on th greater for the less than for the more refrangible the law of variation with refrangibility being of somewhat different in the two cases."

Rosenhain ("Glass Manufacture," 1908, 182, 18 to be quite uncertain whether the colour of copper rul

* Abstract of a Paper read before the American Ceramic September 24, 1919.

† From the *Journal of Physical Chemistry*, xxiii., No. 9.

e to metallic copper or to cuprous oxide. In urine glass, the second phase comes out in spangles nably of metallic copper. Žulkowski (*Journ. Soc. Ind.*, 1897, xvi., 284) believes that copper ruby glass its colour to cuprous oxide; but the general opinion inst him (Williams, *Trans. Am. Ceramic Soc.*, 1914; ie, *Dictionary of Applied Chemistry*, 1918, ii., 72), h the evidence is not very conclusive. Zsig- y (*The Chemistry of Colloids*, 1917, 127) says in d to this: "Colloidal copper is interesting because relation to copper ruby glass. The constitution of glass has long been under dispute. Some authors held that the copper is in the form of cuprous oxide others believe the free metal is present. The deci- of this point is scarcely possible by analysis; but has been thrown on it since colloidal copper has having the same colour as copper-ruby glass. ermoser (*Journ. Prakt. Chem.*, 1899, lix., 489) and zer (*Ber.*, 1902, xxv., 1929) obtained brown, Gutbier (*Zeit. Anorg. Chem.*, 1902, xxxii., 355) blue osols by the reduction of copper salts or by electrical tegration. Paal and Leuze (*Ber. deutsch. Chem. Ges.*, xxxix., 1545) have prepared both red and blue hydro- by the reduction of colloidal copper oxide with hydro- or hydrazine hydrate. The necessary copper oxide made from copper sulphate to which potassium oxide and the sodium salt of lysalbinic or protalbinic had been added. The resulting dark blue liquid was ysed and evaporated. The reduction of copper oxide ie wet way by means of hydrazine takes place in two es. At first an orange coloured milky liquid is obtained doubtless contains cuprous oxide. On further reduc- the liquid becomes clear and is coloured deep red. l and Leuze obtained liquids in this manner that were e black in reflected but deep red in transmitted light. s agrees perfectly with the colour of copper ruby glass. author was able to convince himself with a pre- ition of his own make that the red liquid gives the orption lines near line D that are characteristic of per ruby glass. The absorption lines are somewhat er and the maximum is displaced slightly towards C, which would indicate that a partial coagulation set in, whereby flocculent complexes were formed, ilar to the use of gold gelatine solutions on evaporation. pper hydrosols should be investigated further with the a-microscope and also from the standpoint of spectrum ilysis. Red copper hydrosol behaves differently, depend- upon whether it is made with the sodium salt of prot- inic or lysalbinic acid. The first gives an olive green our with sodium chloride, a phenomenon that has been erved in the case of copper ruby glass. The second omes blue when treated in a similar manner."

All that this shows is that colloidal copper may exist l that it is red, which nobody denies. The implied tement is that colloidal cuprous oxide is orange; but it is not necessarily true. Hydrous cuprous oxide is nge, but anhydrous cuprous oxide is red and the loidal precipitates would differ in the same way. The l question is whether cuprous oxide could exist as such glass, for there is no reason to suppose that cuprous cate is red, although it must be admitted that anhydrous assium cuprous chloride is red, which is a bit unex- cted. So far as a red colour with copper is concerned, is not impossible that we may get metallic copper in e case and cuprous oxide in another; but it would be ry important to know whether cuprous oxide can exist such. This ought not to be difficult to determine perimentally because a cuprous silicate glass should be actically optically empty while a cuprous oxide glass ould scatter light. Berry (*Am. Chem. Journ.*, 1887, viii., 9) reports on the occurrence of a red slag from a copper inery containing some metallic copper but not much. eatment with acids dissolved 27 per cent $Cu_2O$, leaving pale yellow slag containing 8·64 per cent $Cu_2O$, 11·69 r cent FeO, and 49·24 per cent $SiO_2$, the percentages ferring to the original composition. Berry considers that the pale yellow is the resultant of green due to the iron and red due to the copper.

Rosenhain ("Glass Manufacture," 1908, 185) says that silver is never introduced into glass mixtures, the reason being that it is so readily reduced to the metallic state from all its compounds that it cannot be retained in the glass except in a finely-divided form, causing the glass to assume a black metallic appearance resembling the stains produced by the reduction of lead in flint glasses. On the other hand, silver yields a beautiful yellow colour when applied to glass as a surface stain and it is widely used for this purpose.

This is not at all what Rosenhain really meant. Silver is not reduced so readily as gold, and the trouble is not that it comes down in a finely divided state, but that it comes down in so coarse a form as to be pulverulent silver. The yellow stain is the colour which the most faintly divided colloidal silver shows by transmitted light. The best yellow stain is obtained with potash-lime glasses. With the hard glasses silver tends to come down metallic. In the case of enamels, silver is added to the mass of the material (Franchet, *Ann. Chim. Phys.*, 1906, [8], ix., 37). Silver carbonate with bismuth oxide gives an intense blue. One function of the bismuth oxide is to hold the silver to the body; but it must also cause a partial agglomeration of the silver because the lustres are blue to green instead of yellow to brown. Experiments should be tried on precipitating silver oxide with bismuth oxide and then reducing the silver oxide, so as to keep the laboratory experiments in close connection with the technical methods. A yellow stain of silver on a blue cobalt enamel gives a green tint.

Platinum and iridium oxide can be used to give greys, especially in enamels, but they are expensive. Glass can be coloured yellow by suspended carbon, the colour of thin films of so-called carbon being yellow. Carbon can- not be used in lead glasses because of its reducing action.

Glasses containing no heavy metals are coloured yellow to yellowish brown by sulphur; but this is apparently due to formation of polysulphides because these glasses are optically empty (Fenaroli, *Zeit. Kolloidchemie*, 1915, xvi., 53). In calcium glasses addition of sulphur gives a blue colour, apparently due to the presence of colloidal sulphur. We do not know at all why colloidal sulphur should eve be blue, but apparently it may be. Wolfgang Ostwald ("Theoretical and Applied Colloid Chemistry," 1917, 187) states that blue and green (colloidal ?) solutions of sulphu can be obtained by introducing sulphur into molten sodium chloride, into a borax bead, into liquid ammonia or into hot organic liquids like glycerine. He considers that thi blue colloidal sulphur is the cause of the blue colour o ultramarine. "Of the many facts which confirm thi view, I would like to emphasise the analogy between th production of ultramarine and the production of rub glass, of blue rock salt, &c. In making ultramarine th necessary salts are melted together at high temperature This yields the grey to white or yellow 'mother of ultra marine.' This product is then reheated, cooled an reheated again, just as in the case of ruby glass, until th requisite colour is obtained. The original product i obviously a molecularly dispersed solution, the particle of which, through reheating, are permitted to condense t colloid dimensions. Support for the correctness of thi view may be found in mineralogy. Mineralogists ar familiar with a complex sulphur-rich silicate compoun known as hauynite, which appears in different colou ranging from colourless to green and blue. It has bee shown that the colourless varieties may be coloured blu or green by heating them with sulphur in a closed tub an experiment entirely analogous to the production of blu rock salt by heating this with metallic sodium."

In strongly alkaline glasses selenium gives a chestn brown colour and the glasses are then optically emp (Fenaroli, *Zeit. Kolloidchemie*, 1915, xvi., 53). In mode ately alkaline glasses the colour is red to pink and submicro can be seen. Potash glasses gives a purer red than so

glasses. If the red glasses are heated to 620°, the colour becomes a pale brownish yellow. Sodium borate glasses containing selenium are often yellow, but turn red when annealed. Colloidal selenium solutions can easily be prepared which are red by transmitted light, almost exactly the colour of arterial blood (Schulze, *Journ. Prakt. Chem.*, 1885, xxxii., 390).

Tellurium in low concentrations colours glass coral to purple-red, in higher concentrations a steel blue. I have not been able to find any reference to a coral-red colloidal tellurium, but the blue one is easy to obtain. In aqueous solution tellurium seems to come down either brown or blue. *The blue is obtained by reducing a dilute boiling* mixture of sodium tellurate and sodium protalbinate with aqueous hydroxylamine hydrochloride. The reduction *takes place slowly, the solution becoming first brown* and then opaque and the colour changing gradually to brownish violet, bluish violet, and to indigo blue. It will *clearly be necessary for somebody to make a red* colloidal solution of tellurium or to show that the coral colour is due to something else.

Enamels (Thorpe, *Dictionary of Applied Chemistry*, 1918, ii., 333) are "vitreous compositions capable of adhering by fusion to the surface of metal or of pottery. The base of the enamel is generally a colourless glass in which are suspended particles of an opaque metallic oxide or salt generally stannic oxide. Up to about 900° tin dioxide exists finely suspended in the enamel, but at a higher temperature combination or solution may occur and opacity is diminished. Titanic oxide has been used in place of stannic oxide, and antimony compounds have been employed. Opacity may also be obtained by the use of arsenious oxide, calcium phosphate, cryolite, or fluorspar. A preparation known as artificial cryolite sometimes replaces the mineral. When bone-ash is used, a little nitre may be added to remove the colour."

The opacity produced by these added white compounds is due to the difference in refractive index. Natural tin oxide, for instance, has a much higher refractive index for yellow light than glass. While titania has been used as a *substitute for stannic oxide, it is not a very good one* because it gives a yellow tint. Haber (*Journ. Soc. Chem. Ind.*, 1914, xxxiii., 49) states that six million kilos of stannic *acid a year were used for enamelling iron, and that this* amount was halved when people stopped mixing and melting the oxide with the other constituents of glass and *merely added to it* the enamel just before baking. In the old process a great deal of the stannic oxide was actually dissolved in the glass and consequently did not increase the opacity. Impure zirconia is now being used as a substitute for tin oxide in producing opacity. If the zirconia goes into solution as oxide or as silicate, it does not cause opacity (Grunwald, *J. Soc. Chem. Ind.*, 1911, xxx., 210). Of five crystalline titania glazes which were examined (Endell, *Journ. Soc. Chem. Ind.*, 1911, xxx., 210, 489), four contained rutile and one probably asgenite. Practically all the titania had crystallised. In a crystalline zinc glaze the crystals resembled willemite. An opaque yellow lead glass is obtained with antimony oxide, the second phase being apparently lead antimoniate, sometimes called Naples Yellow. The black lustre of the Greek and Roman pottery has been reproduced (Franchet, *Comptes Rendus*, 1911, cliii., 1907) in an oxidising fire at 850° by fluxing 55 parts of quartz sand with 45 of sodium carbonate and grinding the frit with an equal weight of magnetite. Artificial ferroso-ferric oxide does not yield the black colour which is probably enhanced by traces of manganese in the natural ore. The opacity of the enamel is caused by the presence of more stain than will dissolve in the flux. Franchet states that the black enamel was known to the Egyptians and consequently was not discovered by the Greeks. Foster (*Journ. Am. Chem. Soc.*, 1910, xxxii., 1259) considers that ferrous iron, presumably as ferrous silicate, is the cause of the black colour; but Franchet's experiments seem pretty con-

According to Seger (Collected Writings, 1902, ii.
802, 920) "bluish black paving and roofing tiles are
in the lower Rhine districts and in Flanders by a
process called blue-smoking. As soon as the fin
temperature has been reached the flues on top of th
arch are uncovered at the places where they connec
the openings in the arch, and the openings them
(excepting two or three) are stopped tightly with
and clay. Thereupon green alder wood is charge
the firing flues, about eighteen sticks per burn for
of the dimensions given, and the fire-holes as well
ash-pit doors and the upper flue openings are wall
*and daubed as rapidly as possible.* The action
heat on the green wood results in a large volume
and a thick smoke fills the entire kiln. These gases
*not burn since the necessary air is lacking and* they
burn partially at the expense of the oxygen taken
the ferric oxide of the clay; the red ferric oxide com
tions are thus changed to the black ferrous compoun

"Since this process through which the clay ass
the blackish blue colour is reversed as soon as the
tion of gas from the wood ceases, the black ware is
to turn red again as soon as air enters through the
of the kiln which can never be avoided. This i
vented by cooling the kiln as rapidly as possible
charging the wood, which is accomplished by evo
steam in the kiln from water poured on to the arch
order to avoid a direct flow of water through the crac
the kiln the sand covering the arch, the latter
18 cm. thick, is moistened by sprinkling and is s
tamped. Small dams of soft clay are put up aroun
arch holes and water is pumped or carried up so t
stands several centimetres deep on the arch and
maintains a steady evolution of steam in the interi
the kiln which prevents the admission of air.
obvious that such a radical procedure is bound to i
the kiln and arch seriously, and it is readily unde
why the kilns undergo general repairs twice a year.

"The roofing tiles thus blue-smoked withstand wea
ing much better than the red ware, and for this r
*the wise council of the city of Ghent* has decreed th
roof areas fronting the streets must be covered with
tiles, and the use of red tiles is permitted only for
*buildings and the sides turned towards the yards.*

"*It is not absolutely necessary that alder* wood be
for the process described; it may be replaced by
fuel, giving off a large volume of similar gases
instance, the same effect could be produced by the
duction of coal-tar into the kiln, after the latter has
closed up air-tight; likewise in place of wetting the
the part of the kiln most easily injured, the kiln cou
cooled rapidly by injecting a spray of water into the
say, in the ash-pits."

"The manufacture of black vitrified bricks is
branch of the English brick industry, which has be
very important in regard to brick architecture, thou
Germany it appears to be entirely unknown thus far.
desire to employ these black bricks is spreading a
us. Like the English architect, the German b
requires a black material to produce certain cont
but the material which the brickmaker furnishes fo
purpose differs so much in the two countries that it i
worth the trouble to examine the difference more cl
and see if anything of value can be drawn fron
English process.

"*Where black bricks are required for* architec
ornament with us they are made by boiling ordinary
brick in coal-tar. These bricks are no doubt improv
weathering qualities by the tar, *but as dust soon* co
on them they present an unsightly appearance;
original, intense, somewhat glossy black in time p
into a *disagreeably dead colour—a grey.* Many such
coated bricks are also to be seen in England, as
method is cheap; but in the better class of brick struc
their use is excluded and *they are replaced by a* ma
hat is incomparably finer and more durable

.l structures extensively employ brick coated )lack lead glaze for the same effect, but the glitteraces of glaze offend the eye. As regards appearie English products stand midway between the

ı reader may recall the process of blue-smoking ed in the manufacture of black roofing tiles and nd described in an account of the Belgian clayg industry. A similar process is again met in ı brickmaking, save that the effect of the dark is enhanced by a kind of glaze possessing a matt not to be confounded with the appearance of our lead glazes.

e process for the produ^t'on of the brick in question, 'blue Staffordshire bricks,' or 'iron bricks,' from ppearance and hardness, has its home in the centre Staffordshire potteries, and in the south, in Bishops am, not far from Southampton. The clay used is ginous but rather refractory clay; the bricks profrom it approach in appearance closest those known Berlin market as Rathenow bricks, or those that ıde from a clay originating from the weathering of d carboniferous sandstone in the Saarbrücken coal The clay for the brick is generally well prepared, y by slumming. To produce a denser and more :d surface the better grades of brick are always ssed. Burning is carried on to vitrification either in dinary Staffordshire kilns previously described or in :r ones similar to them, of round shape about 3·5 s in diameter and 2·5 metres high, arched over, and with six fire boxes distributed round the circumferand four to six small chimneys set on the semiar crown for the exit of fire-gases. The bricks are them in such a manner that six flues are spared out, ng from the fire-boxes and meeting in the centre in .ical flue, and the faces which are intended to beblack are left exposed in the setting. Thus for ing purposes the bricks are set flat, for paving on always so that those faces laid outward in the contion are left uncovered in the kiln.

Vhen the heat in the kiln has risen so high that the s have passed into the vitrified state, several shovels lt are thrown into every flue. In the intense heat the /aporises at once and covers the exposed faces of the with a very thin, hard glaze. At the same time a charge of coal is supplied, and before the coal is pletely ignited the fire-doors and chimneys are tightly :d and daubed up.

The smoke thus produced has an effect similar to that .e blue-smoking of the Belgian roofing-tiles with alder d, though it is less intense. A blackening of the clay ie depth of several millimetres due to the reduction of iron takes place; this action is augmented by the :s from the salt fumes that are filling the kiln, and a dense and hard coating, dull glazed, and of the :arance of graphite, is produced on the faces of the ks, thus creating a perfectly weather-proof exterior. ı process is employed with brick not for the sake of colour effect alone, but also on the most extensive e for those products where the first consideration is stance to weathering influences and mechanical ısion, such as roofing and floor tiles."

Some of the Rhine and Lorraine establishments make :llow flooring tile, coloured with iron, consisting of a itic refractory clay with sand and a large amount of : as a flux. When these are smoked in saggars, a r good black is obtained. The addition of calcium oonate in the shape of chalk or similar material, not y adds a flux to the body but also prevents warping l makes possible the production of exact surfaces. periments have shown the remarkable fact that mixes of fire-clay with chalk show a minimum shrinkage en there is about 25 per cent of calcium carbonate."

Egyptain blue (Laurie, *Proc. Roy. Soc.*, 1914, A, lxxxix., ) is crystallised $CaO.CuO.4SiO_2$. It is formed between ° and 900°, above 900° a green glass being obtained. The reaction is reversible, for blue crystals are formed if the green glass is held at 850°.

Glass can be coloured yellow with colloidal cadmium sulphide, and Horner (CHEMICAL NEWS, 1874, xxix., 66) has produced a yellow of this sort in a boric acid bead. It really would be a good thing if somebody were to take up the whole question of colours in the borax bead so as to determine which were due to colloids and which to true solutions; and also to find out definitely what chemical compounds cause the colour in each particular case.

(To be continued).

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## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, March 18, 1920.*

Sir J. J. THOMSON, O.M., President, in the Chair.

THE following papers were read:—

"*A Form of* Botrytis cinerea *with Colourless Sclerotia.*" By W. B. BRIERLEY.

A form of *Botrytis cinerea* with colourless sclerotia is described. This was obtained by the isolation and growth of a colourless sclerotium, which was formed in a culture of a normal strain derived from a single spore. The primary origin of the change resulting in the albino form is located in the hyphal mother-cell from which the initial colourless sclerotium arose. Morphological and physiological comparison of the new strain and its normal parent fails to reveal any difference save that of sclerotial pigmentation. This lack of colouring matter is correlated with presence of an oxydase of the laccase type and absence of a chromogen in those tissues which in the normal form contain the black pigment.

Lotsy's dictum that "certainty of purity is a *conditio sine quâ non* to obtain proof of the existence of mutation in living beings" is accepted, and it is shown that such a state is possibly not realisable in the fungi. Anastomoses of mycelium are common, and give rise to heterocaryotic or heteroplasmic cells; this condition of protoplasmic combination being maintained by both sexual and asexual reproduction. New organic systems are thus formed possessing new physiological potentialities, and interacting with the environment to produce new morphological facies.

It is suggested that somatic fusions resulting in a change of genotypic values are the mechanism whereby evolution in the fungi has taken place. Single spore strains, or "pure lines," may be heterocaryotic or heteroplasmic, and the structure of fungi is such that quantitative rearrangements of cell-content are possible, giving rise to so-called "mutations." These changes in genetic constitution are not true mutations, but the result of mechanical segregation in an impure stock.

The present case is interpreted in the light of thi hypothesis.

"*Preliminary Account of the Meiotic Phenomena in th Pollen Mother-cells and Tapetum of Lettuce* (Lactuc sativa)." By R. R. GATES.

In a preliminary study of meiosis in the pollen develop ment of lettuce, several points have appeared which hav a general bearing on cytological conceptions and th problems of genetics. The exceptional condition has bee found in lettuce, in which every intergrade occurs betwee pollen mother-cells and tapetal cells. Even synapsis ha been observed in binucleate tapetal cells, which emphasise the physiological aspects of the synaptic contractior The tapetal cells are peculiar in being often very muc

elongated and lying lengthwise of the anther. Ultimately they break down and form a plasmodium surrounding the pollen grains.

Cytomyxis also occurs, though rarely, during the stage of synapsis in the pollen mother-cells.

There are nine pairs of chromosomes in diakinesis, and they form a graded series, the members of each pair usually lying parallel and partly or completely fused. In the earlier stages, when the chromosomes are long and narrow threads, the members of a pair are frequently looped or wrapped around each other, showing clearly the chiasmatypy described by Janssens in Batrachoseps, which has been used by Morgan and his students as the basis of the hereditary phenomenon known as "crossing-over" in Drosophila.

In diakinesis, occasionally eight bivalent chromosomes occur, owing to the end to end coalescence of two bivalent chromosomes, or their failure to separate. Later, in the metaphase of the heterotypic mitosis, coalescence of four bivalent chromosomes in pairs frequently takes place, *leading to the formation of seven chromosome bodies.* This coalescence is apparently end to end, and appears to take place most frequently between the smaller bivalent chromosomes. Such behaviour of the chromosomes has not previously been described in any other organism so far as I am aware. It furnishes a possible basis for the hereditary phenomena known as partial coupling and repulsion.

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## SOCIETY OF CHEMICAL INDUSTRY.

(BIRMINGHAM AND MIDLAND SECTION).

*Thursday, March* 25, 1920.

Dr. ARTHUR SLATER, Burton-on-Trent, read a paper on "*The Estimation of Carbon Dioxide and Fermentible Sugars*," and described an apparatus devised originally to estimate the total amount of carbon dioxide formed when sugars were fermented by yeast. It was subsequently found to be of general use, and could be employed in most cases where the estimation of that gas had to be made. The apparatus consisted of a distillation flask connected to a condenser; a large trap prevented spray and froth being carried over during the distillation of carbon dioxide from the flask to the "assay" flask which contained standard baryta water. A test-tube to which had been sealed a piece of glass tubing could be connected to the side piece by means of pressure tubing, and the whole apparatus could be evacuated through a stop-cock. The estimation of carbon dioxide in sodium carbonate was carried out in the following manner:—25 cc. N/10 sodium carbonate was placed in the flask, and the test tube was filled with dilute sulphuric acid. Into the "assay" flask 30 cc. N/10 baryta water. The apparatus was exhausted, a screw clip being placed on the pressure tubing to prevent the acid in the test-tube passing into the distillation flask. The acid in the test-tube was warmed and boiled with the flask. Both flask and test-tube were well boiled, and the "assay" flask shaken to absorb the gas. When the distillation was complete, air, free from carbon dioxide, was allowed to enter the apparatus through the stop cock. The excess of baryta in the turbid solution in the "assay" flask was then titrated with standard hydrochloric acid, using phenolphthalein as an indicator. Previous tests made by titrating baryta water containing a suspension of barium carbonate showed that rather more standard acid was required to change the bright pink colour to a faint pink than was necessary when no carbonate was present. In those estimations that correction was added to the apparent amount of alkali neutralised by the carbon dioxide. Special precautions were necessary if volatile acids other than carbon dioxide were present, and if insoluble salts were present care had to be taken that all the carbonate was acted upon by the acid, but in most cases the method acted satisfactorily. The estimation of sugars by alcoholic fermentation offered possibili[ties of] interest. If the fermentation reaction could be put [on a] quantitative basis it should be possible to estimate [sugars] and mixtures of certain sugars and other carbohy[drates] without any appeal to the optical activity or the red[ucing] properties of the sugar. The fall in reducing pow[er or] the change in optical activity after complete fermen[tation] measured the amount of sugar present. The idea [was to] extend the use of pure cultures of yeasts and emplo[y the] fermentation reaction itself to estimate the sugar.

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## NOTICES OF BOOKS.

*The Manufacture of Intermediate Products for Dyes* [...] JOHN C. CAIN, D.Sc. (Manchester), F.I.C. S[econd] Edition. Pp. xi+273. 1919. London: Mac[millan] and Co., *St. Martin's Street. Price* 10s. *net.*

ALTHOUGH only in its second edition, the first being [pub]lished in 1918, Dr. Cain's work has become an aut[hority] on the manufacture of intermediate products for dye[s].

Before a dye is produced from the raw material [at the] disposal of the manufacturer several intermediate pr[oducts] have to be made, and prior to the publication of this [book] there was no single volume on the market which deal[t with] this subject. The literature dealing with this mo[st im]portant branch of chemical industry is spread over [many] books, and the author says in his preface that he d[oubts] whether there is any single library in England that [con]tains the whole of the literature.

For this reason alone Dr. Cain's book is welcome, [as] it he gives the method of preparation of these comp[ounds] on a technical basis, giving the exact quantities o[f the] materials necessary, as were given in the original pat[ent] method of manufacture.

Such processes as chlorination, sulphonation, &c [...] described fully in one of the manufactures, but the d[etails] are not repeated again, being only referred to.

The book is interspersed with 25 diagrams illust[rating] plant that is used on the commercial scale, leavin[g out] such ordinary plant as sulphonation pans, filter pr[esses], &c. At the end of each compound whose manufact[ure is] discussed, is given a short paragraph enumeratin[g the] dyes for which the material is used.

An appendix is given for the conversion of the sp[ecific] gravities of acids and alkalis into percentage compos[ition]. A table is also given for the comparison of the hydro[meter] degrees according to Baumé and Twaddell with specific gravities.

The book should prove a great help to manufac[turers] and chemists, also to students of technical chemistry.

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*The Chemistry of Coal.* By JOHN B. ROBERTSON, [...] B.Sc., A.I.C. Pp. viii+96. London: Gurney [and] Jackson, 33, Paternoster Row, E.C. 1919. 3s. 6d.

THIS little book well fulfils its purpose, namely, to in[troduce] to would-be research workers on coal constitution [the lines] along which investigation would possibly lead to co[nclusive] conclusions.

The text is divided into ten sections, together w[ith a] good bibliography and a fairly good index. Secti[on I.] deals with the classification and occurrence of coal; Section II. with its origin. Sections III., IV., an[d ...] are an epitome of the results and conclusions o[f] various workers on the nature of the constituents of [coal].

The arrangement of the matter in these three se[ctions] is commendable. The next four sections are o[n the] analysis of coal, while Section X. deals with the prop[erties] of coal on combustion. In the determination o[f the] calorific value it is somewhat surprising to find the [...]

wire advocated in the combustion. Even when omy is considered, the advantages of using platinum are more than sufficient to warrant its use.

regards the printing, errors are few and far between. page 37 "*homogeneous*" should obviously read mologous."

pleasing and useful feature of the book is the summary at the end of each section, and generally the author be congratulated on supplying a long-felt want.

## CORRESPONDENCE.

### "LECTURE EXPERIMENT UPON COMBUSTION."

*To the Editor of the Chemical News.*

,—The "phenomenon" described by Mr. Price in your of March 26 is not "of the nature of a gas-cap," flame observed being that of ordinary combustion of l-gas burning in excess of air. Neither in this ance, nor in the case of a gas-cap formed above an flame, is *the gas "burning below its actual ignition-nt.*" The true explanation of the formation of the ne is the one given by Mr. Price in his last paragraph. 'he presence of the wire lowers the velocity of the ed gases, and so allows the gas to burn, but the comtion cannot be transmitted to the uprising gas as its ocity is greater than the rate of propagation of ning." An explanation of the *mode of formation of* rue gas-cap and of the flame described by Mr. Price l make their difference clear.

When an oil flame is introduced into an inflammable mixture, the latter ignites, and a flame passes through mixture, continuing to burn until all the mixture has lamed, even if the oil flame be removed. The heat duced by the burning gases is of itself sufficient to se the adjacent unburnt gas to the ignition temperature. *the percentage of combustible gas* be below the lower it of inflammability, flame will not propagate, since a rning layer of gas will not produce the required amount heat to raise the temperature of the contiguous layer unburnt gas to the ignition temperature. Extra heat y be supplied by an external source, such as an oil me, and the gas immediately surrounding the flame may *en be kept at its ignition temperature* with the help of is extra heat, and a gas-cap is formed. It will be seen at the gas-cap can only form round the oil flame, and n only persist while the latter is kept in the mixture. e increase in height of the cap with (1) a higher testing me and (2) a higher percentage of inflammable gas is plained in this way, being due to the extra heat provided, th the heating up *of a larger quantity of gas to the* nition temperature.

The fact that the flame described by Mr. Price persisted ithout the assistance of external heat at once distinguishes from the gas cap. The experiment described is similar the well-known experiment illustrating the principle of e Davy safety lamp. If a piece of wire gauze be placed ove the mouth of a Bunsen burner, *the gas stream may* ignited above the gauze, but will not strike back rough the gauze. *In this present* experiment the wire ts as a "gauze" of a single strand.

The usual appearance of the Bunsen flame is due to the ct that the gas mixture issuing from the burner tube ontains insufficient oxygen for the complete combustion f the coal-gas. All the available oxygen is burnt up at e inner cone of the Bunsen flame, and the excess of coalas is burnt as it *comes into contact* with the oxygen of e outer air. In the experiment described, the gas issuing om the burner tube mixes with the required external air for complete combustion before it reaches the gauze or wire, and so above this we get the ordinary pale blue flame of ordinary combustion of coal gas burning in excess of air.

It is to be hoped that Mr. Price will not continue to use *this experiment to illustrate gas-caps* to his students, as it will be seen that it is entirely misleading.—I am, &c.,

WILLIAM PAYMAN, M.Sc. (Tech.).

Home Office Experimental Station,
Eskmeals, Cumberland.

## NOTES.

THE Department of Overseas Trade understands that the Roumanian Government have given instructions to allow the free transit of all goods destined for the Serb, Croat, and Slovene State which arrive at Danubian ports. It is, however, *essential that the ship's manifests, bills of* lading, &c., as well as the packages themselves should be clearly marked "Transit pour la Serbie," as otherwise they are liable to detention by the Roumanian Customs Authorities at the port of arrival.

BIBLIOGRAPHY OF SCIENTIFIC LITERATURE REGARDING HELIUM.—(*Bur. Standards Circular* 81, 1919).—The year 1918 marks the beginning of a new era in the history and use of helium. Before that time only a few litres of the gas had been collected and the cost per litre was enormous. During the war the development of great fractionating plants capable of separating *from natural gas a sufficient* quantity of helium to supply a fleet of airships has aroused the keen interest not only of engineers and scientists, but also of the general public, in the unique properties of this gas. This circular contains a bibliography of the scientific literature relating to helium prepared for use during the war and now published. Related *papers are grouped together in their chronological order*, making the bibliography, in effect, a brief outline history of the subject.

THE "PRECIOUS" AND "RARE" METALS.—The ores of Sudbury, Ontario, carry platinum, palladium, and other metals of the platinum group, also gold and silver. The latter two, when spoken of collectively, are usually referred to as the "precious metals," and for clearness sake, platinum, palladium, &c., may be called "rare metals." *In point of value "rare metals"* are at the present time worth per ounce six times as much as gold, and one hundred times as much as silver. Exact figures cannot be given for the precious and rare metal contents of the mattes produced at Sudbury, as these undoubtedly vary from year to year, being to some extent dependent upon the class of ores smelted. Certain deposits of the rocky type are richer in these constituents than the more massive ore bodies, and the whole subject of the association and *method of occurrence of platinum, and especially of palladium*, in the Sudbury ores, is as yet not thoroughly understood. For the three years ending in 1915 the average contents of the precious and rare metals in the Canadian Copper Company's mattes were 0·10 ounces platinum per ton, 0·15 ounces palladium, 0·05 ounces gold, and 1·75 ounces silver. At this rate, the mattes *produced by the company in 1916, amounting to 56,405* tons, are estimated to have obtained 5640 ounces of platinum, 8460 ounces of palladium, 2820 ounces of gold, and 98,709 ounces of silver. Of the precious metals a greater proportion is actually recovered than of the rare metals. For example, in 1916, as is shown in a table, the gold recovered amounted to 3495 ounces and the *silver to 110,285 ounces, in each case considerably more* than the theoretical contents based on the average of the three *preceding years*, while of platinum the yield was 1016 ounces, of palladium 1345 ounces, and of rhodium metals 257 ounces.

Hints on Working Aluminium.—In response to numerous enquires they have received from works foremen and operatives on the subject of working in aluminium, the British Aluminium Company, Ltd., have prepared a series of booklets to supply the desired information in a concise and handy form. These booklets are comprised in a series called "Hints on Working Aluminium," each booklet dealing with a specific branch of the subject. They can be obtained by persons interested on application to the British Aluminium Company, Ltd., 109, Queen Victoria Street, London, E.C. 4, who will also be glad to give any further information required which is not covered by the series of booklets.

The Spring Meeting of the American Chemical Society will be held with the St. Louis and University of Missouri Section in St. Louis, April 13 to 16 inclusive. Every indication points to the fact that the meeting will be one of the largest and most interesting ever held in the West by the American Chemical Society. St. Louis is the centre of the rapidly growing Middle West, and contains large and varied chemical interests. It has always been the leading drug centre of the West, and leads the country in the production of synthetic pharmaceuticals, alkaloids, and anæsthetics. St. Louis possesses all the units of a balanced self-sufficient chemical industry. It is a centre for ceramics, glass, paint, lead, and zinc manufacture. The following excursions are planned:—Laclede By-products Coke Plant; Monsanto Chemical Works, East St. Louis Plant; Laclede-Christy Clay Products Plant; Standard Oil Refinery, Wood River, Ill.; and Illinois Glass Company, Alton, Ill. The membership of the American Chemical Society has increased from 5603 in 1911 to 13,686 in 1919.

## MEETINGS FOR THE WEEK.

*Monday, April 12.*

Royal Society of Arts, 8. (Cantor Lectures). "Aluminium and its Alloys," by Dr. Walter Rosenhain.
Society of Chemical Industry, 8.
Royal Institution, 5. (General Meeting).

*Tuesday, April 13.*

Royal Institution, 3. "Recent Advances in X Ray Work," by Major G. W. C. Kaye.
Institution of Civil Engineers, 5.30.
Institute of Metals, 6.30.
Royal Photographic Society, 7.

*Wednesday, April 14.*

Society of Public Analysts, 8. "Turbidity Temperature of Fats, Oils, and Fatty Acids," by A. E. Parkes. "Interpretation of Milk Records," by Dr. G. W. Monier-Williams. "The Loss of Free Ammonia from Drinking Water Samples," by Dr. A. F. Joseph and G. A. Freak. "A Decanting and Filter Washing Machine," by E. Sinkinson.

*Thursday, April 15.*

Royal Institution, 3. "Ebullition and Evaporation," by S. Skinner.
Royal Society of Arts, 4.30. "The Ports of India," by Sir George Buchanan.
Chemical Society, 8.
Institution of Mining and Metallurgy, 5.30.
Institution of Electrical Engineers, 6.

*Friday, April 16.*

Royal Institution, 9. "Ions and Nuclei," by Prof J. A. McClelland.

*Saturday, April 17.*

Royal Institution, 3. "The Thermionic Vacuum Tube as Detector, Amplifier, and Generator of Electrical Oscillations," by Prof. W. H. Eccles.

# NOTICES.

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E CHEMICAL NEWS

VOL. CXX., No. 3131.

## E STRUCTURE OF MATTER AND THE QUANTUM THEORY.

### PART I.

By F. H. LORING.

all quiescent matter is only *apparently* inert as the movement of its parts is pretty generally :d, but there is an absence of direct evidence of types of movement, in particular *rotational* as :d by the expression: *one body rotating round* .

true that a study of the movements of the heavenly reveals various types of activity, including the fore- ons, and these are assigned to negative electrons arying conditions. Inasmuch as man stands mid- tween two great systems of activity, it is reasonable ose that the atomic universe is not so different from llar universe as to involve a different system of tics; yet, there is the *possibility of having to deal* at might be termed a complementary system of lynamics when formulating the activities of elec- r even atoms and molecules, should these entities sufficient state of electrical unbalance.

following statements from Jeans' "Report on ion and the Quantum Theory," p. 48, in a sense rise the present position of uncertainty with regard interpretation of certain cognate phenomena. The 's introduced, for purposes of reference, are mine.

us, according to this view, *which is supported by* reater volume of evidence than can be referred to 1) The hydrogen atom consists of a negative n revolving in an orbit round a positive nucleus al charge, while the helium atom consists of two ns revolving in orbits round a nucleus with a e charge equal in amount to twice that of an n. (2) The inability of the Newtonian mechanics ain line spectra becomes evident if we fix our atten- the hydrogen atom, which consists of two point s only, one *positive* and one *negative*, and yet he highly complicated spectrum associated with en. (3) We are at once led to inquire why these harges continue rotating round one another, of falling into one another, as the energy of notion is dissipated by radiation. And how ch a simple system give a spectrum containing y lines? The number of degrees of freedom of tem is only six, three of which represent its ability e in space. How, then, can so many vibrations be e? (4) And, again, *why does not the energy of* vibrations appear in the measure of the specific

To all these questions the Newtonian mechanics e no answer. The answer given by the quantum- is, perhaps, only partial, but, as we shall see, it is vincing that little doubt can be felt of its funda- accuracy."

of course possible that one may eventually come to *energy* as having an entity characteristic that can- perceived by itself, and it is only the *effect* of this , *acting through the agency of matter proper, that* itself known; consequently, unless one has suitable tus to be acted upon by such energy, the apparent f inertness is manifest. This statement obviously s to the domain of speculative philosophy. If, r, this idea be true, then it is the energy itself that ly move in some cases, in which circumstance a quantum of energy is not after all such an absurdity. The somewhat advanced idea is, that rotational energy can only increase or decrease in steps, so that when a body rotates with $n$ r.p.s. its energy is always a whole-number of times the product $h\ n$, $h$ being Planck's constant. *There are, however, very serious difficulties which stand in the way when radiation is involved.* The revolving electron is, nevertheless, suggestive of some such action.

Referring now to Jeans' statements, considering (1) the question to be asked—*Is there any directly-observed case known in molecular physics of one body rotating round another?* In the study of literature on molecular phenomena, I cannot find a satisfactory answer to this question; but in my own experience there appears to be an answer.

Suffering occasionally from eye-fatigue, possibly involving some abnormal condition in the eye, I have often noticed when awakening in the morning with the eyes turned towards a bright white ceiling, groups (sometimes many groups covering the entire ceiling) of sharp black *round spots revolving uniformly round each other at about* 160 r p.m. These spots are about equally spaced and of uniform blackness. The effect disappears very quickly and it has to be preconceived to be observed properly. No doubt eye specialists could furnish interesting examples of this kind.

This is not of course an orbital-electronic movement, *but it is certainly a uniform rotational movement*, of the above-mentioned type, of something in the eye, presumably particles of like molecular or atomic composition, *rendered visible by some such phenomenon as occurs* when X-rays are reflected from crystal planes. This effect may involve light absorption or interference in the eye, as distinct from what might be described as a converse resultant action when X-rays are synchronously reflected from planes rich in atoms.* However this may be, the similarity of X-rays and white light is made suggestively apparent. It is now believed that white light consists of irregular pulses which become transformed into trains of sine-waves by the optical apparatus itself (see Wood, "Physical Optics," *1914*, p. *648*). That X-rays have also this characteristic, in so far as they originate as irregular pulses, is probable, judging from the experiments and views of the Braggs and others, whilst Stokes' pulse-theory of X-rays is generally accepted. For a statement of this theory, based upon the sudden stoppage of a moving electrified particle, see Crowther, "Ions, Electrons, and Ionising Radiations," 1919, p. 143. The penetrating power of X-rays is of course due to their exceedingly short wave-length.

*It seems to me that the eye-effect opens up a potential* field of experiment with white light and organic or transparent matter in which movements are supposed to take place, since it ought to be possible to get a moving picture of what is going on in masses of matter in which life activity is known to exist. By some such method of investigation one can almost expect the mechanism of life to be formulated, very much as the mechanism of the atom is now being explored, and the knowledge gained in one such field of research should be of great value to the *workers in other fields*.

There are of course Brownian movements which may result from relatively finer-grained movements, and the microscope has revealed many coarse-grained movements, but so far as I know, there is nothing on record of actual "molecules" or particles in uniform rotational movement round each other. (See Perrin, "Atoms," chapter iii., iv

* The expression, *a plane rich in atoms*, is best understood by arranging a group of equally-spaced dots on a piece of paper and drawing straight lines through the dots to intersect different numbers. *The line which cuts through the greatest number of dots represents a* plane particularly rich in atoms. By further construction, when wave pulses strike into or across a mass of dots (atoms) it will be seen how it is that those waves (secondary ones = diffracted pulses) which originate from given sets of planes reinforce one another, and it is by this action that small pencils of light emerge from the crystal and produce the spots on the photographic plate. See W. H. Bragg and W. L. Bragg, "X-rays and Crystal Structure," 1918, Chap. xii.; see also Tutton, CHEMICAL NEWS, 1913, cviii., p. 301.

and v. Perrin mentions irregular spinning or rotational movements, pp. 126 and 113).

With regard to (2), there is now considerable evidence of the existence of whole-number isotopes scattered through the Periodic Table (see CHEMICAL NEWS, 1919, cxix., pp. 14, 62, 199, 280; and 1920, cxx., p. 73) and it has been suggested by eminent authorities that spectral lines have their origin not in one atom as a fixed type or species, but in a number of atoms; and it is, therefore, a rational step to consider the hydrogen atoms as not absolutely identical; in fact they may have second-order isotopic properties in that they vary slightly in mass, but probably this variation, if it exists, will be in the *n*th decimal place. Postulating slight orbital differences amongst the electron-systems with mutual influences would perhaps help to account for the complexity of line-spectra. Bohr's mathematical treatment of the Rutherford atom, involving spasmodic emissions of radiation, appears to be so satisfactory that whatever mechanism is adopted it should not be in substantial conflict with the equations formulated by this Dutch physicist. For example, the contractions or expansions indicated by Bohr's theory may not all be confined to one species of atoms, but the actions may be distributed over a series of atomic species, and this brings one at once to Planck's resonators, or some such idea involving, say, isotopes. *There is, however, a difficulty here.* The X-ray spectra of certain isotopes (radio-atoms of the same atomic number) have been found to be the same, the wave-lengths belonging to the L-series of Barkla. The two-line X-ray spectra of many elements (see Moseley's experiments) cannot be attributed to dual isotopes of the first order, *i.e.*, those differing in mass by units 1, 2, 3, 4, &c.—to cite a simplified case. The principal line is, however, a *doublet*, and there are other lines. Whether the doublets arise from sets of atoms which are different in mass is of course a possible consideration, but in the case of the ordinary luminous spectra of isotopes the line difference is so slight that the general cause of spectral complexity can hardly be attributed to whole-number isotopes (see CHEMICAL NEWS, 1920, cxx., p. 73). It will be seen that in pursuing this argument and the one that the instability of matter (whereby it radiates electric waves under stimulation, or electric currents flow more or less freely through metals) is influenced by whole-number isotopic proportions, leads to ideas more or less in direct opposition. How then are the complex spectra to be accounted for? Even in the case of hydrogen there is a considerable number of lines. The answer seems to be a very fundamental one, and it may be related to the mechanism, so to speak, of Prout's hypothesis. Had Prout lived to-day, he might have attempted to explain why four hydrogens of atomic mass 1·008 each make up an atom of helium containing by measure four whole-number units of mass; that is to say, a mass without having a fraction in the early decimal places.

*Electromagnetic theory may explain this loss of nth decimal place mass when the fundamental union of hydrogen atoms takes place in the production of a fixed atom. Eminent authorities support some such view.* Now it may be that this *contraction* in mass, if I may use such a term in this connection, is a variable quantity if the hydrogen atoms vary amongst themselves in mass, this variation being of a second-order magnitude, and therefore appearing only in the *n*th decimal place. Since the energy involved (given out) in producing this *mass contraction* is considerable, the ability of the atoms or their orbits to execute certain vibrations or changes in orbital configuration may be in proportion to their energy content, and the energy differences may be a function of *h*, *h* in turn being the "elastic-limit function" of the orbit by analogy (see CHEMICAL NEWS, 1920, cxx., p. 73, S. c. 12), which in turn is modified by the "contraction energy" of the nuclear mass. Reasoning of this kind may be objected to, but there seems to be no other way out of the difficulty. *Sound* affords a possible example here. Suppose a series of porcelain plates were suspended at intervals on a cord passing through their centres (holes being drilled purpose) and that these plates were struck with hammer. Each plate would emit a sound char of its *contractile hardness* in firing (other thin equal), if I may coin this term, which represents th locked up in the plate.

In returning to the hydrogen atoms, it will be the suggested mass-variation in the *n*th decimal pl lead to considerable amounts of energy involved ducing this variation. *The spectrum therefore be energy distribution; or, the spectrum is represen such energy.* This argument brings to mind th scheme I roughly developed (CHEMICAL NEWS, 19 pp. 157 and 181), which may be abstracted in part Assuming the hypothesis of the evolution of the first put forward by Crookes, as a starting po hypothesis may be extended, which extension re the evolution of the elements by means of a cyclic similar to a hysteresis loop with internal compl indicating changes in magnetism when the mag force is periodically withdrawn and re-applied d general progressive variation. Such a figure is es an energy cycle, thus keeping in the foreground of work being performed in the process. It is that elements can be formed when there are tim or "rests" in the continuity or activity of energy the sense that when the impelling or accelerating withdrawn and re-applied a new phenomenon itself, as if the stored or impressed energy had powers to form certain elements.

*There is another aspect of this problem.* Ne second-order mass variations amongst the atom given element as represented by variations in decimal place, and applying the electromagnetic n tion of mass, some rather suggestive figures are which are given below. Fourth-decimal-place v in mass are not, of course, discussed, and the eva of 3rd decimal place figures are uncertain. D (*Nature*, March 4, 1920) has confirmed the curre of hydrogen, 1·008, by the positive-ray meth helium appears to be a whole number without a f at least without one in the third decimal place.

If $1 \times 1{\cdot}008 = 1{\cdot}008$ (*a*) and
$4 \times 1{\cdot}008 = 4{\cdot}000$ (*d*), then
$2 \times 1{\cdot}008 = 2{\cdot}004$ (*b*), and
$3 \times 1{\cdot}008 = 3{\cdot}002$ (*c*) (*not* $H_3 = 3{\cdot}024$).

*a* = hydrogen. *d* = helium.
*b* = nitrogen sub-atom. *c* = fluorine sub-at

Therefore, carbon and oxygen should be—

12·000 made up thus:—3He,
16·000 made up thus:—4He,

and nitrogen and fluorine should be—

14·004 made up thus:—3He+*d*,
19·002 made up thus:—4He+*c*.

Now, Rutherford (*Phil. Mag.*, June, 1910, pp 587; see also CHEMICAL NEWS, 1919, cxviii., —abstract—corrections, p. 311 V should read 2nd line top right, *upon* should read *beyond*; an middle of same column, 106 should read 10⁶) has detached *b* from nitrogen, and therefore by a simil ment of fluorine, the bombardment should yiel disrupted member of the normal fluorine atom. up helium, however, means, according to the tren present argument, that the applied energy must great, since an enormous amount of concentrated must be represented in contracting the 0·008-par sub-atom to a negligible quantity by comparison fourth-decimal-place quantities are not considere method is one of first approximation.

It would appear that when the sub-atomic locked up, or rather linked up, it locks the pa

the complex atom, very much as a keeper clapped [...]he poles of the magnet gives rise to increased [...] lines or linkages through the keeper, and work [...] performed to pull off the keeper. If the weight [...]eeper when away from the magnet is A, and the [...]t of the magnet without the keeper is B, then the [...]t of the magnet with its keeper in place should be slightly less than A+B (see in this connection [...]ICAL NEWS, 1917, cxv., p. 181). Now, *mass* and [...]t are interconnected terms so related as to represent [...]nstantial variations of the same general phenomenon, but to discuss this dual aspect would lead to the modern generalised relativity dynamics. This additional complexity involving ideas of Einstein can, however, be avoided by simply regarding the ratio of mass to weight as being *constant* in a given gravitational field, or at a given place on the earth's surface—to bring the conception home. Therefore, in the above statement, the term *mass* can be substituted for the term *weight*, and as a corollary, to continue from the preceding paragraph, an enormous amount of energy would have to be expended on atoms to cause them to disintegrate. If, therefore, a missile striking

| Elem't | | $n \times$ He | a | b | c | d | Isotopes & Prop. No. | | | Mean & Exp. Mass | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Li | = | $1 \times 4+$ | | | 3 | | = 7 | $3^3 \times 7$ | = | 6·93 | 6·94 |
| | | $1 \times 4+1$ | | | | | = 5 | $1^3 \times 5$ | | | |
| Be | = | $1 \times 4+$ | | | | 4 | = 8 | $4^3 \times 8$ | = | 9·06 | 9·1 |
| | | $1 \times 4+$ | | 2+ | | 4 | = 10 | $(2^3+4^3) \times 10$ | | | |
| B | = | $2 \times 4+$ | | | 3 | | = 11 | $3^3 \times 11$ | = | 10·93 | 10·9 |
| | | $2 \times 4+1$ | | | | | = 9 | $1^3 \times 9$ | | | |
| C | = | $2 \times 4+$ | | | | 4 | No Isotopes | | = | 12·000 | 12·00 |
| N | = | $3 \times 4+$ | | 2 | | | | | = | 14·004 | 14·008 |
| O | = | $3 \times 4+$ | | | | 4 | | | = | 16·000 | 16·000 |
| F | = | $4 \times 4+$ | | | 3 | | | | = | 19·002 | 19·00 |
| Ne | = | $4 \times 4+$ | | | | 4 | = 20 | $4^3 \times 20$ | = | 20·22 | 20·2 |
| | | $5 \times 4+$ | | 2 | | | = 22 | $2^3 \times 22$ | | | |
| Na | = | $5 \times 4+$ | | | 3 | | = 23 | $3^3 \times 23$ | = | 22·93 | 23·00 |
| | | $5 \times 4+1$ | | | | | = 21 | $1^3 \times 21$ | | | |
| Mg | = | $5 \times 4+$ | | | | 4 | = 24 | $4^3 \times 24$ | = | 24·22 | 24·32 |
| | | $6 \times 4+$ | | 2 | | | = 26 | $2^3 \times 26$ | | | |
| Al | = | $6 \times 4+$ | | | 3 | | = 27 | $3^3 \times 27$ | = | 27·07 | 27·1 |
| | | $7 \times 4+1$ | | | | | = 29 | $1^3 \times 29$ | | | |
| Si | = | $6 \times 4+$ | | | | 4 | = 28 | $4^3 \times 28$ | = | 28·22 | 28·3 |
| | | $7 \times 4+$ | | 2 | | | = 30 | $2^3 \times 30$ | | | |
| P | = | $7 \times 4+$ | | | 3 | | = 31 | $3^3 \times 31$ | = | 31·07 | 31·04 |
| | | $8 \times 4+1$ | | | | | = 33 | $1^3 \times 33$ | | | |

a carbon or oxygen atom is massive enough and the velocity is very considerable, dismemberment into helium atoms should take place. *The order of break-down should be roughly*—

N, Ne($\beta$) see table below, F, O, C, He.

By means of this study, the following atomic masses are consistently arrived at, and these should be compared with those given in the "Report of the International Committee" (CHEMICAL NEWS, 1920, cxx., p. 40):—

| | |
|---|---|
| Hydrogen .. .. .. .. | 1·008 |
| Helium .. .. .. .. | 4·000 |
| Carbon.. .. .. .. .. | 12·000 |
| Oxygen .. .. .. .. | 16·000 |
| Nitrogen .. .. .. .. | 14·004 |
| Fluorine .. .. .. .. | 19·002 |
| Neon ($\alpha$) .. .. .. .. | 20·000 |
| Neon ($\beta$) .. .. .. .. | 22·004 |

That carbon is possibly near to the above value seems likely since the following values give a mean of 12·0006 :—

| | |
|---|---|
| Richards and Hoover .. .. .. .. | 12·005 |
| Batuecas (1918) .. .. .. .. .. | 11·999 and 11·996 |
| Mean of earlier determinations .. .. | 12·0025 |

Dr. Aston reports (*loc. cit.*) that nitrogen is a pure whole-number member like carbon, but the new positive-ray method is probably not quite exact enough to determine whether there is a third-place decimal value in this case. I believe that the general opinion of chemists is that nitrogen has a fractional value in the *neighbourhood of 0·004, certainly not less and possibly more.* The current accepted value is 0·008.

Taking into account (1) Dr. Aston's recent discoveries of whole-number isotopes and (2) the opinions long held by some mathematicians (see, for example, Strutt—now Lord Rayleigh—*Phil. Mag.*, 1901, i., p. 311) that from probability considerations the atomic weights must somehow be whole-numbers in accordance with Prout's hypothesis, and (3) some of the deductions I have already made in my studies, and also (4) Sir Ernest Rutherford's disruption of $H_2$ from the nitrogen atom, lead me to think that the structure of the elements (atoms) might be formulated along some such lines as follows :—

*Let it be assumed that the helium atoms (4·000) are* the bricks out of which the atomic structure is made, and that certain atomic outriders (sub-atoms) are added to the structure thus formed, these outriders being represented by the following multiplication table in which the mass contraction is due to the interaction of electric fields (see above); then, let it further be assumed that when isotopes occur in the process of evolution, their number is proportional to the masses of the outriders.

*An Electromagnetic Multiplication Table.*

$H_1$ = 1·008 × 1 = 1·008 ($a$)
$H_2$ = 1·008 × 2 = 2·004 ($b$)
$H_3$ = 1·008 × 3 = 2·002 ($c$)
$H_4$ = 1·008 × 4 = 4·000 ($d$)

Attempting to carry into effect the foregoing proposition leads to the accompanying scheme (see large table) which gives mass values not in conflict with the latest experimental atomic weights. *In evaluating the proportionate* number of isotopes I have cubed the mass of the outriders. The extra outrider apparently carried by beryllium is of possible interest.

With regard to (3), there appears to be no evidence that a revolving pair of particles, as in the eye-effect, should emit radiations any more than a spinning closed-magnetic-circuit magnet will give out electromagnetic disturbances. That such pairs should revolve is as much a natural necessity as that they should be at rest. One state is as difficult to account for as the other; and I am inclined to the view that *had scientists become thoroughly with movement first, it would be a matter of account for relative non-movement or rest.* Giv endowed with a certain amount of energy, t must manifest itself, though potential, in s Perhaps the word *latent* would be better than *p*

The perfect pairing of two entities precludes bility of any radiating disturbance. If, howeve fect relation is disturbed then radiation takes this brings to mind the state of initial instabili due to isotopes, which I discussed in my prev cited above. The emission of light is evident to entities free from disturbing influences, emission seems to be due to orbital changes or arising partly from a state of mutual instability losses of energy amongst the atomic system spasmodic, evidently suffer reinforcement aris chemical changes, or the *supply* of electrons as candescent electric lamp : the converse of the ph effect. The binding effect of chemical combin *not be lost sight of, as it affords one extreme in* electronic freedom is reduced to a minimum cases.

With regard to (4), the specific heat is und molecular- or atomic-energy effect, as distinc isolated electronic-orbit effect, and it resides in solid vibrations of the atoms (Debye). Wh elastic effect is involved a quantum of ene necessarily involved; but *there may be no need t idea so far as to assume that the effects arise fro duce, parcels of energy dotted over a wave-* CHEMICAL NEWS, 1920, cxx., p. 73).

(To be continued).

## THE STRUCTURE OF ATOMS

By Prof A. BERTHOUD.

(Concluded from p. 173).

THE importance of these results from the point the classification of the elements is seen at the intermediate question, however, the princip of Moseley's law is that it indicates the existe interior of the atom, of something—some q magnitude—represented by the atomic number, creases regularly as we pass from one eleme succeeding one.

What is the nature of this magnitude; wh represent in the atomic edifice?

An answer to this question has been given by of the $\alpha$-rays, which in their passage through m revealed the fundamental characters of atomic

An essential fact is that the $\alpha$-rays (of r instance) are capable of passing, without suf considerable dispersion, through metallic film hundredths of a millimetre in thickness, layers of gas several centimetres thick. Re that these films of metal or layers of gas are thousands of juxtaposed molecules, the possibi $\alpha$-particles passing between the interstitial completely excluded; they must traverse t themselves.

This phenomenon would be inconceivable if were solid. It shows that their structure mu contrary, be of a very lacunar character. The be composed of particles very small as compare own dimensions, and separated by spaces relatively considerable, and these particles or can be *nothing else but electrons, positive or ne*

* Address to the Société Helvetique des Sciences September 7, 1919, at Lugano. From the *Revue ures et Appliquées*, October 30, 1919.

-particles, however, do not pass through matter suffering any dispersion at all, and the deviations lergo, under the action of the electric forces of e atom is the seat, give valuable information as istribution of the positive and negative charges.

explanation of these deviations was offered by homson, to whom is owing a conception of the which positive electricity is supposed to be dis- uniformly through a sphere whose volume corre- with that of the atom, whilst negative electrons are ated regularly therein. But although this con- has filled a useful *rôle* in the development of ideas ing atomic constitution, it does not account for observed facts. An $\alpha$-particle, in traversing such , would never undergo more than a slight change tion. Considerable deviations, of which a small are always observed, are attributed to repeated ers. A close analysis, however, of experimental by Geiger and Marsden indicates that this sup- does not conform to the facts. An encounter single atom can give rise to a considerable devia- metimes exceeding 90°. This conclusion has since rified by direct observation of the trajectory of the les, using Wilson's method.

embering the enormous velocity of the $\alpha$-particles it nt that such deviations can only be produced by a tense field of force, such as could not exist in on's atom. To obtain a field sufficiently powerful ecessary to suppose, with Rutherford, that the charge is not distributed through the whole volume tom, but that it is collected in a very small region centre, whilst the negative electrons circulate this nucleus at a relatively great distance from it. om is thus pictured as a miniature solar system, in the sun is denoted by the nucleus and the planets ative electrons more or less numerous.

very satisfactory manner in which Rutherford's accounts for the law, according to which the r of $\alpha$-particles deviated from a given angle varies nction of their velocity and the size of the angle, utes an important confirmation of that theory.

nearer an $\alpha$-particle or a $\beta$-particle approaches the s the greater will be its deflection from its original and from the amount of deviation it is possible to ate the distance from the centre at which the particle . In this way we can obtain an idea of the timate dimensions of the nucleus, and demonstrate treme smallness. From Rutherford's calculations, ample, the diameter of the positive nucleus of the atom is not greater than $3 \times 10^{-12}$ cm.; it is there- bout 10,000 times smaller than that of the atom With hydrogen, as one would expect, the nucleus n smaller. From the maximum velocity which an icle imparts to a hydrogen atom on impact, we can e that for hydrogen and helium the sum of the radii nuclei does not exceed $1 \cdot 7 \times 10^{-13}$ cm. The atomic us of hydrogen is therefore of smaller dimensions the electron.

ally, the dispersion suffered by $\alpha$- or $\beta$-particles in sing matter has allowed of the evaluation of a itude having a fundamental importance—namely, of the electric charge on the positive nucleus. erford's results confirm the opinion previously put rd by Van den Broek, that this charge, taking that electron as unity, is denoted by the atomic number. ydrogen, therefore ($n = 1$), it is simply equal to that e electron; for helium ($n = 2$) it is double; for lithium ) it is three times the value, and so on. Thus we see ignificance of the atomic number, the importance of h has already been referred to. It is now easy to give how the nucleus charge may be the factor h determines the properties of the atom, but before ing further into this question a few preliminary re- s are necessary.

the outset we may remark that the equality of the ic number with the positive charge of the nucleus is in complete accord with the "laws of displacement" men- tioned above, and the explanation of this will be seen if we assume that the $\alpha$- and $\beta$-particles emitted during radio- active transformations come from the nucleus. It will be clear, if this is so, that the emission of an $\alpha$-particle, carrying two positive charges, will diminish the nucleus charge by two units, and will consequently result in a dis- placement of the element by two steps in the sense of decreasing atomic numbers. If, on the other hand, a $\beta$- particle is emitted, the positive charge, and therefore also the atomic number, is increased by one unit.

The number of negative electrons which revolve around the nucleus, and which compensate the positive charge, must also be equal to the atomic number, since the atom considered as a whole, is electrically neutral. It therefore does not exceed 92, and, consequently, these exterior electrons constitute but a very small part of the mass of the atom. This mass is thus concentrated almost entirely at the nucleus. Hence the density of the latter (if it is permissible to use the word "density" here) is extra- ordinarily high. For gold it would exceed 600 millions, which is equivalent to saying that the nuclei of gold atoms which a single cc. could hold would weigh more than 600,000 tons.

It is of interest to note that, long before the foregoing factors were known, considerations of quite another order relative to the specific heats of monatomic and diatomic gases had already suggested that the mass of an atom must be concentrated towards the centre.

The positive charge of the nucleus does not represent merely the number of positive electrons which the nucleus contains. There is no doubt that negative electrons also enter into its constitution. They are necessary to ensure its stability. The apparent charge is determined by the number of positive electrons in excess, as compared with the negative electrons. It is, however, probable that with hydrogen the atomic nucleus is reduced to a simple positive electron, the mass of which will therefore be nearly equal to that of the atom, or 1830 times as great as that of the negative electron. Though no ready proof of this can be given, it is the simplest and most probable hypothesis, and is not contrary to any known experi- mental fact.

To explain the relatively great mass of the positive electron it is by no means necessary to assume the pre- sence of a material basis. It suffices to consider the electricity as being concentrated in a very small volume, and the diameter of the positive electron as being 1830 times less than that of the negative electron. An experi- mental determination of the former diameter is at present impossible; but certain observations indicate, as we have seen, that it is in fact much smaller than that of the negative electron.

Thus the positive electron reveals itself as the smallest corpuscle which enters into the constitution of matter, and at the same time as that to which bodies owe almost the whole of their weight. Since its mass is sensibly equal to that of an atom of hydrogen, the number of positive electrons contained in an atom is represented by the rounded-off value of the atomic weight. (The atom of sodium, for example ($Na = 23$), would be formed of 23 positive electrons, all contained in the nucleus, and an equal number of negative electrons. Of these last, 11 are exterior to the nucleus; the other 12 form part of the nucleus, the positive charge of which is therefore equal to the atomic number 11). We are thus brought back to the old hypothesis of Prout, though a new form of it. According to Prout all atoms are composed of hydrogen atoms. This hypothesis, which has given rise to numerous discussions during the course of the past century, has already retained some partisans, for if the atomic weights are not whole multiples of that of hydrogen, as Prout affirmed, the difference is, in general, very small, especially with the lighter atoms, and the concordance cannot be simply chance. Nor, to-day, does it seem im- possible to account for those larger differences which in

the past have led to the rejection of Prout's hypothesis.

Formed of the two kinds of electrons closely apposed, the atomic nucleus must be the seat of extremely intense fields of force. We need not conclude that it is absolutely rigid, and that the constituent corpuscles are completely immobile in relation to one another. Doubtless they have some irregular motion, comparable with the thermal agitation of atoms in a molecule. Only thus can we conceive of spontaneous radio-active disintegration arising. But these movements bring into play enormous forces compared with which those shown in chemical reactions are negligible. This is the essential reason of the great stability shown by positive nuclei and by the atoms themselves, and to this is due the inefficacy of all the means hitherto tried (with possible exceptions not yet confirmed) with a view to disintegrating the atoms and liberating their store of energy.

Beyond this we have no exact knowledge as to the constitution of the nucleus, and this is understandable if we recall the fact that, stability excepted, the properties of the atom are independent of the nucleus. In all probability, however, the positive electrons are, for the most part, united in groups of four, which preserve a certain individuality in the electronic aggregation. This may be deduced from the fact that in the radio-active emission the fragments detached from the atom are always either isolated electrons or α-particles ($He++ = 4$).

The properties of the atom, except mass and radioactivity, depend directly upon the electrons which circulate around the nucleus. But it is clear that not only the number of these but also their relative positions, the diameters of their orbits, and their velocities, are determined by the charge of the positive nucleus and the field of force to which this charge gives rise. It follows, therefore, that in the ultimate analysis it is this charge which determines all the properties of the atom. We can now perceive the fundamental importance of the atomic number which expresses the value of the charge, and the phenomenon of isotopy also now becomes explicable.

The nuclei of two isotopes are not identical; they do not contain the same number of positive or negative electrons, and the arrangement of the electrons may also be different. Thus they have not the same mass nor the same stability (radio-activity), but in each there is the same excess of positive electrons over negative electrons; their positive charges are therefore equal, and this equality carries with it the identity of all their chemical and physical properties.

Rutherford's theory explains, therefore, two facts of fundamental importance, namely, the *rôle* of the atomic number and the existence of isotopes. Its interest is thus of quite another order to that which attaches to the interpretation of the dispersion of α- or β-particles during their passage through matter. But though there is good reason to think that it gives us an adequate picture of atomic structure, it is only a first stage on the way, and leaves us still further from the end in view; for an important objection now appears.

Just as a vibrating string sends off sound-waves into space, so an electron, revolving rapidly round its nucleus, should, according to the laws of electro-magnetism, emit radiant energy (infra-red, luminous, ultra-violet, or X-rays). Losing its energy thus its velocity should diminish, and describing gradually smaller and smaller circles it should, so to speak, eventually fall into the nucleus. Hence the atom, as pictured by Rutherford, would not persist; it would form an unstable system.

Bohr has endeavoured to meet this difficulty and complete Rutherford's theory (*Phil. Mag.*, 1913, xxvi., 1, 476, 857; see also Nicholson, *Month. Not. Roy. Astr. Soc.*, 1912, lxxxii., 49, 139, *et seq.*).

It is known that the physical theories current during the past century, based on Maxwell's equations, do not suffice to account for the laws of radiation from black substances. To explain these laws Planck has propounded the celebrated quantum theory, according to which th of an oscillating body, such as an electron, can in a discontinuous manner by giving up an number of energy quanta, each quantum being, n stant magnitude, but the product of the frequen universal constant.

This theory is adopted by Bohr as the basis of ceptions concerning the movements of the outer e In the hydrogen atom, for instance, the single which revolves around the nucleus can only follow circular orbits, designated by successive numbe mencing with the smallest. In traversing one circles with a uniform motion the electron, contra teaching of classical physics, emits no radiant ene there is throughout equality between the centrifug and the attractive force exerted by the nucleus varies as the inverse square of the distance. electron cannot be in a condition of equilibrium these rings. If under the action of an external f electron leaves its orbit it passes immediately to circle of stability. It is during this jump that the gives out energy, in the form of electro-magnetic and the emission is each time equal to a quan energy.

Such are the essential postulates on which Bohr his theory. They are not all easy of acceptation, the mind least prone to conservatism. But the of the conceptions lies in this: they account with able exactness for the series of lines which constit luminous spectra of certain elements.

The spectrum of hydrogen comprises a series (29 are known) of which the frequencies can be cal from Balmer's empirical formula—

$$v = 3{\cdot}29 \times 10^{15}\left(\frac{1}{4} - \frac{1}{m^2}\right),$$

by replacing the variable $m$ with the series of numbers 3, 4, 5, &c. Now, Bohr's theory le Balmer's formula; it accounts therefore for all th of this series, which corresponds with the rays when the electron passes to the circle 2 from the ci 4, 5, &c.

Two other series of lines, less important, hav observed in the hydrogen spectrum, one in the ultr (observed by Lyman), the other in the infra-red (Pa Bohr's theory indicates these lines also, and w exactness which leaves nothing to be desired. Th are emitted when the electron falls on the circle others when it falls on the circle 3.

With the helium atom, which possesses two electrons, the problem is much more difficult, but consider the helium ion ($He+$), consisting of a n with two positive charges round which revolves a electron, the calculation can be made as in the of hydrogen, and here again the theory is bril successful. It has enabled several series of lines calculated which have actually been observed i helium spectrum. It has even led to the correction error which had arisen through attributing to hyd certain spectrum rays really belonging to helium.

It has done yet more. Most of the spectrum li hydrogen and helium are not simple; with suffic powerful instruments they can be resolved into s components. Sommerfeld has happily perfected B theory in a way which supplies a very satisfactory ex tion of this phenomenon. He assumes to begin wit the orbits of the electrons are not solely circles but el also. The energy of an electron depending only o length of the major axis of its orbit, it follows that i passage of an electron from an orbit of given major a another orbit of major axis also given, the spectra emitted, determined solely by the variation of ener the same, whatever may be the eccentricities of the el of departure and arrival. The same spectral line is emitted in several different ways.

The foregoing, however, is strictly correct only i

of the electron is supposed to be constant. But it ...wn that this mass depends on the velocity. Now, ... take into account the variations of mass of the ...on due to change of velocity during its elliptical ...n, we arrive at the result that the spectrum lines cor...nding with orbits of different eccentricities will not be ...ly coincident. Thus Sommerfeld's theory affords an ...nation of the complexity of the spectrum lines, and ... comparison of the calculated results with those ...ved shows, especially with helium, a remarkable ...ment. Theory here is even ahead of experiment, for ...alculated components are often so close to one another ... no spectroscope is powerful enough to separate ...

...we pass to the other elements the difficulties become ... great. Electrons distributed over a multiplicity of ...s influence one another, and form very complicated ...ms which have so far baffled analysis. There are ...ns for thinking that as the number of outer electrons ...ases they form new rings, whilst those first formed ...t without change as regards the number of electrons ...n occupy them, though not as regards their diameters. ... may suppose that this periodic appearance of new ... of electrons corresponds with a periodic change in ... properties which depend upon the surface of the ... If a property is a simple function of the charge ...ot a periodic one, it is to be presumed that it brings ... play those electrons only which are closest to the ...us. Such is the case with the high-frequency ...rum.

...oreover, in this respect Bohr's theory gives something ... than the above qualitative indication. It accounts ...oseley's law. The calculation shows that the $\alpha$-lines ...e K series would result from the passage of an ...on from ring 2 to ring 1, whilst the $\alpha$-rays of the L ...s are emitted when the electron passes from ring 3 to ...g 2.

... these results are full of promise; they justify us in ...ing that Bohr's theory, whatever changes the future ... bring for it, does correspond with realities and ... research has taken the right direction. But if the ...mental characters of atomic structure may be re...d as now known, the details, as already stated, escape ... nearly all cases. Nevertheless, efforts tending to fill ...ese structural details have not been wanting, inspired ... very diverse conceptions, and seeking to utilise ...vations of widely differing nature, for there is no ...em which has more keenly tested the sagacity of the ...stigator, nor any domain where imagination and even ...y have been given a freer field.

... we cannot yet represent each atom by a model which ...s all the details of its structure and which renders ...t of all its properties, a way has been opened which ...er or later will surely lead to this possibility, and ... of our ascribing all the forms of matter to simple ...ences in the arrangement and in the movements of ...ltimate particles of two primordial elements, positive ...ricity and negative electricity.

## THE COLOURS OF COLLOIDS.*

By WILDER D. BANCROFT.

*(Concluded from p. 176).*

...ING back to the glasses and glazes, we know that at ...n concentrations of the colouring oxides a second ...e appears. Thus it is possible to make a chrome ...turine glass in which one can see the second phase, ...gh we do not know definitely whether the new phase ...romium oxide or a chromium silicate. It should be a ...ively simple matter to settle this question once for

* From the *Journal of Physical Chemistry*, xxiii., No. 9.

The general question of the ordinary colouring oxides in glass is a puzzling one however. Spring (*Rec. Trav. Chim. Pays-Bas*, 1900, xix., 339) says that glasses coloured by silicates of iron, chromium, manganese, and cobalt are optically empty, in which case they must be true solutions either of the oxides or of the silicates. On the other hand we have seen that stannic oxide, zirconia, titania, magnetite, and probably cuprous oxide can exist as second phases under certain conditions, and it is consequently by no means certain that Spring's observations apply to all glasses. Wolfgang Ostwald ("Theoretical and Applied Colloid Chemistry," 1917, 186) states that the artificial rubies owe their colour presumably to a colloidal chromium as do the Alexandrites, &c.; but this is somewhat vague.

While it is very probable that many of the coloured glasses are true solutions, the chemistry of the subject is so much up in the air and the problems have been side-stepped so skilfully in the books that it seems worth while to jot down some of the things that we do not know about the subject even though it may not come strictly under the heading of the colours of colloids. Iron usually colours glass green or yellow; in glazes one may get blacks, blues, browns, and reds. If we consider the iron as dissolved in the glass we should expect to get a green with ferrous salts and a yellow with ferric salts by analogy with aqueous solutions, and that is what we actually do get. There are difficulties in regard to this, however. While ferrous sulphate with seven of water is green, the salt with one of water is colourless, and it is a question how far one is justified in reasoning from the aqueous solution to the silicate solution. Copper sulphate is blue when dissolved in water and green when dissolved in glycerine. The yellow colour of the ferric salts is also a little troublesome because ordinary ferric oxide is red and the yellow is found usually as a hydrous form. This difficulty is not necessarily serious because a yellow ferric oxide is said to be obtained by the oxidation of ferric sulphide (Diamond, *Journ. Soc. Chem. Ind.*, 1918, xxxvii., 451) and we get yellow bricks when we burn a highly calcareous clay containing iron (Keane, *Journ. Phys. Chem.*, 1916, xx., 734; Scheetz, *Ibid.*, 1917, xxi., 570). It seems probable that a finely-divided and porous ferric oxide may be yellow and not red, though this has not yet been proved.

In glazes where the red colour is due to iron, the ferric oxide is present as such and is not in solution. At high temperatures ferric oxide is instable and either breaks down or goes into solution. In the latter case it gives a pale yellow colour. The stability at high temperatures is increased very much if the ferric oxide is mixed with chrome oxide. The native chrome iron ore has the composition $FeO.Cr_2O_3$, and is a magnetite in which the ferric oxide has been replaced by chromic oxide. The synthetic mixture probably does not form this compound at all. With high chromium content the colour is greenish black and with increasing content of ferric oxide it passes through brownish black to reddish brown and then to a light yellow brown. As has been pointed out, one also gets a black with magnetite which is intensified by the presence of manganese oxide. We do not know to what the blue is due, though it is possible that a suitably finely divided magnetite might give a blue, in which case the cyanogen radical might not be the theoretically important factor in the ferrocyanide and ferricyanide blues.

Solutions of cobaltic salts are blue and so are concentrated solutions of cobaltous salts. It is quite possible that finely divided cobaltous oxide is blue. There is one characteristic of cobalt (Segers, "Collected Writings," 1902, ii., 654) which "causes difficulties in its use as an underglaze colour, namely, that of taking up more oxygen on being heated in contact with air than corresponds to the blue oxide. At the moment of fusion the excess of oxygen is given off and is very apt to cause bloating of the glaze. The best protection against this danger consists in combining the cobalt with alumina. In this way

a blue substance is obtained which is much less sensitive to a continued excess of oxygen as well as to reducing influences than pure cobalt oxide. The latter, as well as the cobalt oxide-alumina complex, produce a dark blue colour. If a light blue is desired, an addition of zinc oxide must be made. The more intense the ignition the lighter it will be. Various tints can be produced from the colours of the cobalt oxide by adding other metallic oxides. An addition of nickel oxide gives greyish blue tints as well as that of iron and manganese oxide, the latter two being less intense in their effect. Uranium oxide acts similarly. By means of chromium oxide all tints of bluish green can be obtained."

Manganese colours glass amethyst to violet (Thorpe, "Dictionary of Applied Chemistry," 1918, ii., 721). "The full colour is only developed when the manganese is in a fully oxidised condition ($Mn^{IV}$) and can be altered or discharged by introducing reducing substances." This sounds well, but it is a little confusing to turn to the article on "Manganese" and be told that the colour of the amethyst (see also Scholes, *Journ. Ind. Eng. Chem.*, 1915, vii., 1037; *Journ. Soc. Chem. Ind.*, 1916, xxxv., 318) has been attributed to the presence of $Mn_2O_3$ and that pyrolusite has been used to form a black enamel. It is true that in the last case the $MnO_2$ is in suspension; but there seems to be nothing to show definitely to what the colour of the amethystine glass is due. There is still a great deal to be done in the chemistry of the subject. Mixed oxides of manganese and iron give an amber to brown glass.

Schenck (*Journ. Phys. Chem.*, 1919, xxiii., 283) found that when hydrous manganous oxide was precipitated with an excess of hydrous aluminum oxide and the mass heated, it was at first pink, as one would expect, and then changed to brown. He did not determine whether the brown colour was due to manganous oxide or to a higher oxide.

Manganese oxide behaves to some extent like cobalt oxide, taking up oxygen to form a peroxide and losing the oxygen on fusion. This characteristic is less marked when the maganese oxide is precipitated with alumina or with phosphoric acid and tin oxide; also when it is ignited strongly and thus made denser.

According to Wicks and Mellor (*Trans. Eng. Ceramic Society*, 1913, xiii., 61) nickel oxide may give blue, green, yellow, and brown colours in glazes, the colour varying with the composition of the glaze. Increase of alumina makes the colour more stable, with a wider margin of safety in firing. Silica and boric acid deepen the tint and increase the solubility of the oxide. With the alkalis, nickel gives a brown tint which deepens in passing from lithium to potassium. The alkaline earths cause deepening of the brown from calcium to barium. Beryllium gives yellowish brown, magnesium green, and zinc blue. When used as underglaze, nickel colours are attacked by lead glazes, forming the common brown of nickel-lead silicate, which bears a similar relation to nickel-zinc blue that violet cobalt silicate bears to Thenard's blue and Rinmann's green. The nickel colours are not very good.

Perry (*Ibid.*, 1913, xiii. 67) reports that nickel oxide with basic oxides alone or with silica gives colours varying from pale brown to dark olive green. Magnesia produced a strong yellow green (NiO : MgO) and a brilliant light green when stannic oxide was added. Zinc with silica and nickel oxide gave a dark blue powder. Whatever the basic oxide present, introduction of alumina induced a light matt blue. Titania and nickel oxide with or without other basic oxides produced yellow. Stannic and zirconium oxides gave buff or brownish colours. When fired under glazes the behaviour of these stains varied considerably. Colours made from nickel and another basic oxide gave straw brown. The higher the firing temperature and the more energetic the flux, the darker was the brown colour produced. Addition of silica to the powders lightened the colours and imparted a greenish tinge. Blues produced by addition of alumina were very instable under the action of glazes. silica dark blue was also instable under glaz content of zinc in the glaze tended to pr alumina and zinc blues; but as soon as action colour changed to grey and then to brown. greens were also readily destroyed. Titani were fairly stable both as regards firing temper difference in glass compositions. The most sta were those produced by stannic and zirconium o all glazes of the earthenware type nickel tended brown coloration and was only safe for unde when brown tints were used.

Schenck found that when the hydrous oxides and aluminium are precipitated together th green and turns yellow on heating. It is pro with a higher nickel content the mass would ha brown when heated. Nickelous oxide is said green crystalline powder which turns yellow o There is no special difficulty with the greens, ye browns if we assume that finely divided nickelo green and that as it agglomerates it becomes y then brown, brown being merely a dark yell possible of course that the brown is due to the of nickelic oxide; but that is a point which can settled experimentally.

The cause of the blue colour is not known. Th explanation is to refer it to presence of cobalt in salt; but there are difficulties about that Penc *Am. Ceramic Soc.*, 1912, xiv., 143) worked wit salt which he bought as free from cobalt thou not test it himself. With increasing zinc cc colour due to the nickel changed from brow purple to blue. To complicate matters still fu blue is said to be obtained under reducing cond is, of course, possible, though not very prob very finely divided nickelous oxide is blue and n but that would have to be proved.

Cupric oxide gives blue or green. Solution copper salts are blue and concentrated solutions chloride are green. From Schenck's experim copper oxide in alumina, it seems probable t divided copper oxide is blue. We do not kno the blue colour is due to dissolved copper oxid cupric silicate, and we do not know to what colour is due; but there seems to be some regu connection with it. Boeck (*Journ. Prakt. Chem.* xl., 158) found that a turquoise blue enam Persian mosque owed its colour to copper. W cating it in the laboratory, it was found necess soda and potash in a definite ratio. Too m makes the colour too green and too much potas too blue. Since this was a tin oxide enamel, it that the copper oxide was not present as a silic Egyptian blue to which reference has been mad to a green glass when heated above 850 degrees. to facilitate the making of this compound all added to the mix. It would be very interestin whether the glass would be blue if only potash Granger (*Bull. Soc. Chim. Paris*, [4] 1914, reports that in a lime soda or lime-potash glas of a small amount of copper gives a blue whic to green as the concentration of copper rises. seems not to have noticed any specific differenc soda and potash. Substituting boric acid for s first a peacock blue and then a greenish colou there may be no connection, it is worth noting green due to ferrous salts becomes bluer when p are substituted for sodium ones (Thorpe "Dic Applied Chemistry," 1918, ii., 721).

Chromium oxide gives either green or reds. is what one would expect from the colour of solutions. If hydrous chromic oxide is peptised potash we get a beautiful green colour. Th pink has not been accounted for successfull originally obtained with lime and stannic oxid now be made in various ways. In regard to

("Collected Writings," 1902, ii., 654): "The red rs show many peculiarities which must be considered. are obtained when a small addition of potassium omate is made to a mixture of marble and tin oxide, he mass is ignited strongly. Quite a number of salts es potassium chromate produce the same effect, but safest to work with this one. If too much potassium nate is used (over 3·4 per cent) the resisting power e underglaze colour is decreased considerably. If is added to the mixture, the colour turns towards nd towards lilac if the lime is decreased, while the it becomes pure lilac if the lime is omitted entirely. ry strong fire is necessary. The red chromium rs require oxidising conditions and are destroyed by tion though restored on continued oxidation." llor (*Trans. Eng. Ceramic Soc.*, 1915, xv., 131) that the tint of chrome-tin pink is the same no matter chromium compound one starts with, provided the is not underfired. Ramsden (*Journ. Franklin Inst.*, clxxvii., 263) says that lime is essential to the chromium glaze to prevent decomposition of the stain. The oxides in the glaze should consist largely of lead which helps to form a translucent yellow glass im- ng a *blood-red tint to the crimson stain. This does* sound as though the colour were due to basic lead mate or anything of that sort. On the other hand, ner (*Journ. Soc. Chem. Ind.*, 1911, xxx, 1386) seems ke the other view, because he says that only small unts of the alkalis and alkaline earths can be intro- d into a red glaze containing $CrO_3$ because chromium ide plays the part of an acid only in presence of much

If too much silica is present, green and yellow s appear. The fact that the colour is due to oxidation rought out by Rhead (*Trans. Am. Ceramic Society*, xiii., 324), who states that a green glass is obtained mass corresponding to a complex chrome pink formula elted in a fritt kiln, whereas the red is developed in a le kiln. While tin oxide is the usual thing for getting rome pink, Watts (*Ibid.*, 1911, xiii., 301) states that in xidising atmosphere chromic oxide with alumina gives nk with some grey in it. Addition of zinc oxide oves the colour, giving finally a delicate peach-blow . Boric acid counteracts the effects of zinc oxide. er reducing conditions a bright chrome green is ined. Too much alumina destroys the crimson colour nsden, *Journ. Franklin Inst.*, 1914, clxxvii., 263) sses rich in silica tend to acquire a green tint. At 0·5 the order of oxides is CaO, $Bi_2O_3$, PbO, $B_2O_3$, , $Na_2O$, $K_2O$, and $Al_2O_3$, the lime is being the most urable to the production of the red colour. Starting $Al_2O_3$, the oxides become more harmful to the red ur in the following order: $Al_2O_3$, BaO, ZnO, SrO, , *MgO, and $Sb_2O_3$, the oxide of antimony being* h the worst.

With alumina and silica constant an increase of boric changes the colour from a raspberry red to a cherry (Radcliffe and Walduck, *Trans. Am. Ceramic Soc.*, 5, xvii., 278). In the overburned glazes containing c acid, a second boiling or evolution of gas takes e and a green is formed. Glazes in which lead aces calcium change from raspberry red to a lilac n properly matured. In overfired glazes lead has tically the same effect as boric acid, the production of n or mottled green or red colours.

urdy (*Trans. Am. Ceramic Society*, 1912, xiv., 172) rts that brown pinks and brown reds are obtained h high lime; lilac pinks and reds with low lime. e pinks and reds are obtained only with the equivalents CaO 2·0 and 1·5 in the stain. With increase in mium in the $Cr_2O_3$ and $K_2Cr_2O_7$ stain glazes, the s pass from pink to red and then to green, while in the l chromate glazes the tints pass from pink to brown s. The best reds were obtained with $K_2Cr_2O_7$ and the best pure red with $Cr_2O_3$ and lead chromate.

From all this it is certain that the chrome pink is due to oxide of chromium higher than chromic oxide and that the colour is not due to a chromate; but that is about all we know. Silverman (*Ibid.*, 1914, xvi., 548) has made a green chromium glass which is red in greater thickness; but this can hardly have anything to do with the problem of the chrome pink because that is obtained in glasses low in chromium. Increasing the chromium content makes the glass green. The most plausible hypothesis seems to be that the colour is due to chromic anhydride, $CrO_3$; but in that case it must be stabilised by something. This is quite possible, for the colour develops only in the presence of stannic oxide or some similar substance, which would naturally increase the stability. Also Heidingsfeld (*Trans. Am. Ceramic Soc.*, 1913, xv., 140) gives a formula for a chrome pink which is said to be stable at higher temperatures than usual and which is essentially a chrome alumina containing iron. This is interesting because we have already seen that chromic oxide stabilises ferric oxide. The important thing, however, to keep in mind is that we have no proof of what actually *causes the pink* colour and that the best we can do is to guess.

Of course it is possible to postulate hypothetical compounds in difficult cases and to let it go at that. We can say that cobalt aluminate is blue, that cobalt zincate is *green, that cobalt magnesiate is pink, just as we say that* potassium cobalto-nitrite is yellow; but to do that one should show that the definite compounds exist and that they do account for the colour changes. That has not been done and we are left with such empirical summaries as the following (Minton, *Ibid.*, 1914, xvi., 248): "With chrome-alumina calcium gives a fine green while calcium and barium give dark green. Calcium and increasing amounts of zinc give pink to brownish shades. Calcium and magnesium give brown shades, while calcium and lead give fine bright greens. Zinc alone gives light fawn shades, zinc and barium give brown shades, zinc and magnesium give pinkish browns, while zinc and lead give brown and strong pink shades. Barium alone produces yellowish or hedge apple greens, while barium and magnesium give greyish colours. Magnesium alone produces fawn shades and seems to exert a stronger effect upon $Cr_2O_3$ than zinc does."

The actual experimenting is not difficult because one does not have to work with actual glasses and glazes. One can start with borax and phosphate beads and one can precipitate the oxides together, the hydrous oxides of alumina, tin, zinc, and magnesium. That would give fairly definite substances which could be analysed and to which one could apply the phase rule. It is work that anybody could do anywhere and it would be certain to increase our knowledge very much. It is not merely a problem of the ceramic industry. We tell the freshmen every year that manganese colours glass pink and we ought to know *something about the chemistry of it.*

The general results of this paper are as follows:—

1. In glasses and glazes, gold, silver, copper, platinum, iridium oxide, selenium, tellurium, sulphur carbon, lead antimoniate, magnetite, ferric oxide, stannic oxide, zirconium oxide, titanium oxide, arsenious oxide, calcium phosphate, and cryolite occur usually as a second phase. Chromium occurs in some form as a second phase in chrome Aventurine glass and copper in Egyptian blue.

2. Some glasses coloured by iron, chromium, maganese, and cobalt are optically empty. In the enamels the colouring matter is probably chiefly adsorbed by the substance causing the opacity.

3. We do not know what compound produces the pink colour with manganese or with chromium. Some of the nickel colours are unexplained, notably the blue. We have no satisfactory way of accounting for the copper glases being blue in one case and green in another.

4. We cannot predict that cobalt will give a blue with alumina, a green with zinc oxide, and a pink with magnesia.

5. The whole subject of the colouring materials in glasses and glazes needs a careful revision so that the chemistry of it can be put on a sound scientific basis, which is not the case at present.

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, March 25, 1920.*

Sir J. J. THOMSON, O.M., President, in the Chair.

THE following papers were read :—

"*Note on the Central Differential Equation in the Relativity Theory of Gravitation.*" By A. R. FORSYTH F.R.S.

"*Frequency of Earthquakes in Italy in the years 1896 to 1914.*" By R. D. OLDHAM, F.R.S.

The paper is an attempt to discover whether there is any variation in the frequency of earthquakes which can be attributed to the stresses set up by the gravitational attraction of the sun and the moon. In addition to some small and more or less doubtful variations, there was found to be a very marked maximum frequency about the time of the new moon, when the declinations of the sun and moon were of the same sign and at the full when they were opposite, together with an equally marked minimum frequency at the full when the declinations were the same, and at the new when they were opposite. At the quarters the frequency is about average, at the times of minimum the frequency is about one-third, and at the maximum about five-thirds of the average. The magnitude, no less than the fact that it is continuously recognisable throughout the record, shows that the variation is a real one, and it is difficult to find any other cause than the effect of the stresses set up by the gravitational attraction of the sun and moon.

"*New Apparatus for drawing Conic Curves.*" By A. F. DUFTON.

With the apparatus described in this paper the conic is drawn as the polar reciprocal of a circle.

A four-bar linkage constrains a pen to trace the locus of the pole of a fixed straight line enveloping a circle upon paper pinned to a rotating drawing board.

The instrument draws conics with precision. It traces the curves at one sweep and is applicable to all conics.

"*Experimental Determination of the Distribution of the Partial Correlation in Samples of* 30." By Capt. J. W. BISPHAM, R.E.

The distributions are described of the observed values of the partial and total correlations from 1000 samples of 30 each. The three attributes of the sampled (artificial) population are uncorrelated, so that observed values of the correlations are departures from the true value, which is zero in each case.

The three groups of 1000 total correlations observed are shown to be nearly "Gaussian" in form, and to be in very close accord with the distributions predicted in general form by R. A. Fisher, and evaluated in detail in an important co-operative study described in Biometrika.

The distribution of partial correlations is compared with the Gaussian, the Pearson Type II., and with the theoretical distribution of *total* correlations referred to above. It is found to be closely fitted by the latter, and not to show significantly higher dispersion than indicated by the usual expression for the standard deviation of total correlations, viz., $1-\rho^2/\sqrt{n-1}$.

Some important practical bearings of the result are indicated.

### FARADAY SOCIETY.

*Ordinary Meeting, March 1, 1920.*

MR JULIAN BAKER, F.I.C., Chairman of the London Section, was in the Chair at the opening of the meeting, and his place was afterwards taken by Prof. ALFRED W. PORTER F.R.S., Vice-President of the Faraday Society.

Dr. T. MARTIN LOWRY, O.B.E., F.R.S., and Mr. HEMMINGS presented a paper on "*The Properi Powders,*" which embodied an investigation that ha carried out for the Scientific and Industrial Re Department under the auspices of a Committee app by the Council of the Faraday Society.

The caking of salts is, in general, dependent on th sence of a solvent, usually water. The following have been studied :—

1. *Nitrates.*—In the case of ammonium nitrate hard caking follows the change of state which takes at 32° C., but this caking can be prevented by thorough drying. Hard caking also follows mechanical disintegration of the warm salt, but t also attributed to the influence of moisture released c disintegration. Ammonium nitrate crystallised alcohol shows much less tendency to cake than crystallised from water. Caking of ammonium r due to mechanical working is only slight when the ditions are such that moisture can escape from the po

Sodium nitrate forms a very hard cake when sto bulk, but this can be prevented by commercial d whereas it is precisely this process which gives rise t most serious caking in ammonium nitrate. This ference is attributed to the polymorphism of ammo nitrate, which has no analogy in the case of so nitrate.

Potassium nitrate, which is less soluble than eit the two preceding salts, may cake during storage, apparently to a much smaller extent.

2. *Other Anhydrous Compounds.*—Serious caking ported to occur, not only in common salt and in soda but also in potassium chlorate, potassium perchlc citric acid, and tartaric acid. In the last four caking frequently accompanies or follows the grindi the dried crystals. This is probably due to the liber of more moisture during grinding, and can be prev by drying the compound during or after grinding, packing in a dry condition.

3. *Hydrated Salts.*—Caking of hydrated salts frequ gives rise to trouble, *e.g.*, in the case of Rochelle borax, sodium phosphate, and alum. These hyd cannot be dealt with in the same way as anhydrous s since it is difficult to secure complete drying of hydrate without partial decomposition. The vie advanced that mechanical working of a hydrated salt merely releases included moisture, but may result in breaking up of the hydrate similar to that which i place when the salt is heated, just as the phenomena w accompany the formation of amorphous materials d cold-working may be compared with the effects prod by fusion. Grinding is found to be accompanied slight loss in weight which is recovered very quickly the air. It is not thought that this is sufficient to acc for caking of the salt, which is attributed rather t crystallisation following on the disturbance of the no distribution of water which results from the grinding o salt, just as sodium sulphate may recrystallise in normal form after being melted in its water of cry lisation.

4. *Loss of Sulphur Dioxide during Caking.*—So bisulphate and sodium hydrosulphite cake on exposu air, but this is a more complex change, since not on water absorbed but sulphur dioxide is also liberated.

5. *Contraction during Caking of Copper Sulpha* When powdered anhydrous copper sulphate is expos moist air it swells considerably during hydration, bu absorption of the final one per cent of water is accomp both by caking and by strong contraction. The s excess of water taken up by the blocks is quickly lost dry atmosphere when hydration and caking are comp Caking and contraction in this case are believed to be to the simultaneous presence of particles of the trihyd and of water saturated with the pentahydrate, in w the trihydrate dissolves and crystallises out again in ordinary form. The caking of hydrated salts can be

by the presence of a small amount of a lower e, which absorbs the traces of moisture which are ctive in producing caking in a salt which is almost ıydrated.

ntion is directed to the disintegration which accom the change of state of ammonium nitrate when by heat and which is also observed in the dehydra- f many hydrated salts. This disintegration may be is a substitute for grinding, just as in the converse s of slaking lime by the addition of water.

J. A. HARKER, O.B E., F.R.S., said that preliminary ments had recently shown the possibility of making nium nitrate synthetically from its gaseous con- nts. The crystalline form and other properties of itrate made in that way were remarkable, and the as nothing like so deliquescent as the ordinary form. not cake after long keeping.

. H. BERRY suggested that the methods adopted by iakers of table salt might throw light on the subject discussion. His experience confirmed the views of uthors on the effects of moisture, but other condi- were factors. Thus sodium phosphate dried and d with as much as 30 per cent of moisture would ake.

ROBERT ROBERTSON, F.R.S., spoke on the forma- of pellets which was analogous to caking. Ammo- nitrate with about 2 per cent of moisture required pressure to form pellets of definite cohesion than the st dry salt. Other salts, however, were not in line the nitrate in that respect. Possibly impurities came play. The subject called for further study on the line e author's work.

. S. RIDEAL remarked that the important material salt had not been mentioned. During the Boer war ts were made of this material for sterilising water and revent the jambing of the machine caused by the rial caking, lubricating it with boric acid was found e effective. The pellets were not used, and eventually became so hard that they would not dissolve in water l a little sodium carbonate was introduced.

apt. C. J. GOODWIN raised the question as to the effect aking of impurities in the materials.

Ir. J. G. A. RHODIN thought that "cohesion" turning "adhesion" between the crystals, rather than hydra- , was the prime cause of caking. Crystals formed clean solutions having clean surfaces in contact would ngly adhere to one another and form practically a solid stance.

r. R. LESSING said that it was practically impossible to ammonium sulphate unless it was neutral. Was that the case with the nitrate, or did it at any stage con free acid or free ammonia? He put forward a theory plementary to the authors', namely that heating the at a high temperature engendered some dissociation l on recombining the fragments of the dissociated mole- es did not recombine exactly with each other, thus ilitating caking in a measure that water alone would justify.

Mr. R. G. EARLY gave some figures to illustrate the ssure necessary to produce coherence—in the case of linary soluble salts about half-a-ton per sq. in. It peared, however, solubility and pressure did not run rallel, although the less soluble salts were the more sily pressed into coherent blocks. Ammonium nitrate re- ired a small pressure compared with the chloride. Barium lphite would not link under 8 tons per square in., but e chalk went at 2 tons, while calcite, fine or coarse, was ermediate. Fineness of material did not have a great ect, but the amount of mother liquor present was a ctor.

PROF. A. W. PORTER suggested some lines of physical quiry that recurred to him in connection with the pheno- ena of caking. The question as to what was the direct ect of pressure could only be answered if pellet forma- on was conducted at various temperatures. If the effect ... the temperature changes would be large—if physical, small. That followed from thermodynamical considerations. The influence of pressure on solubility should also be considered, and especially the authors' cases where the whole system was not completely under pressure. The phenomena were similar to the solidifica- tion under pressure of water into ice.

Dr. T. M. LOWRY, in reply, said that in the case of common salt impurities were the dominant factor. Reply- ing to Dr. Burns, he thought this was also the case with copper sulphate. English ammonium nitrate was neutral. He had thought that caking had to do with the formation of amorphous material, as happened in the flow of metals under pressure, but when he had been shown ammonium nitrate in a powder which did not change its state, no matter what was done to it, and which was incapable of caking, he was convinced that moisture had a good deal to do with the caking.

Dr. T. M. LOWRY and Mr. S. WILDING then read a paper on "*The Setting of Dental Cements.*"

Phenomena of caking or setting may be divided into five classes:—

I. Covers all the cases described in the previous paper, and includes cases of recrystallisation of anhydrous or hydrated salt without change of chemical composition.

II. Comprises the formation of hydrates as met with in the setting of plaster of Paris.

III. The hydrolysis of complex salts by water, as in the setting of barium silicate and Portland cement.

IV. The formation of new salts, such as the magnesium oxy-cements and the zinc oxy phosphate cements, used in dentistry, and "silicate" cements, in which various sili- cates and salts of aluminium are converted into phosphates by the action of an aqueous solution of phosphoric acid sometimes saturated with aluminium or zinc phosphates.

V. Amalgams in which mercury takes the place of water. The best of the amalgam-cements is that made by the action of mercury on an alloy of silver and tin; Professor J. W. McBain has shown that this is formed by the replacement of the tin in the alloy by mercury.

## MEETINGS FOR THE WEEK.

*Monday, April 19.*

Royal Society of Arts, 8. (Cantor Lectures). "Aluminium and its Alloys," by Dr. Walter Rosenhain.

*Tuesday, April 20.*

Royal Institution, 3. "Recent Advances in X Ray Work," by Major G. W. C. Kaye.

Institution of Petroleum Technologists, 5.30. "Methods of Examination of Lubricating Oils," by G. F. Robert- shaw.

*Wednesday, April 21.*

Royal Society of Arts, 4.30. "The Commercial Future of Airships," by Air-Commodore Edward Maitland.

*Thursday, April 22.*

Royal Society, 4.30. "Elastic Properties and the Plastic Extension of Metals," by Prof. W. E. Dalby. "Ex periments on the Pressure Wave thrown out by Sub marine Explosions," by H. W. Hillier. "A Study of the Catalytic Action at Solid Surfaces," by E. F. Arm strong and T. P. Hilditch. "Structure of the Balmer Series of Hydrogen Lines," by T. R. Merton. "Dia magnetism due to Free Electrons," by Prof. H. A Wilson.

Royal Institution, 3. "The Tensile Strength of Liquids," by S. Skinner.

*Friday, April 23.*

Royal Institution, 9. "Shakespeare's Shylock and Scott's Isaac of York," by Sir Israel Gollancz.

*Saturday, April 24.*

Royal Institution, 3. "The Thermionic Vacuum Tube," by Prof. W. H. Eccles.

Analytical Chemist (A.I.C., Food and Drugs, &c.), knowledge of Bacteriology a recommendation.—Apply, Dr. Martin, C.W.S. Research Department, Corporation Street, Manchester.

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E CHEMICAL NEWS

VOL. CXX., No. 3132.

## IE STRUCTURE OF MATTER AND THE QUANTUM THEORY.

### PART II.

By F. H. LORING.

(Continued from p. 184).

now quote part of a summary containing reasons against a physical basis for the quantum theory, n by Jeans in his Report (pp. 77 to 87). It is just to keep in mind the fact that this summary reprehe work and thought of eminent physicists, and I have attempted to modify or enlarge the ideas in- (see above), this modification is based upon recent rought to light; and, moreover, since physicists onflicting views, I believe that I am justified in a *view so long as it supports the general opinion* igh authority or another. I should, perhaps, iat in formulating briefly answers to the queries i the *Report*, I have *largely drawn from common* e, as even contained in the Report itself—which ie basis of this paper. I insert below in square n excerpt from Millikan's "*Electron*."

:'s result . . . may be summarised as follows:— le heat-energy of an element resides in the its elastic-solid vibrations, the atoms being i the particles of the solid, and each vibration actly the energy allotted to it by the quantum- Nernst has shown that for the compounds by him the same is true except that the mole- at be treated as the particles of the solid, ie energy of the elastic vibrations of the solid dded the energy of the internal vibrations of the , *each vibration again having* exactly the energy it by the quantum-theory.

these theories, as well as the theories of Born an, and *of Thirring, are covered by a general* n that the heat-energy of a solid is the energy ations of the atoms of the solid, each vibration actly the energy allotted to it by the quantum- d therefore having the same energy as a light of identical frequency.

ecalls the result obtained in Section 9, that the for equilibrium between a material vibration and tions in the ether is the equality of mean energy ms of the same frequency. This result was, in obtained from the old mechanics: the specific omenon suggests that it may be true in the nechanics also. The physical bearing of this cussed in the next chapter.

apter. . . . "It has by no means been ible to represent the quantum-theory completely of mathematical equations or of physical con- se *indications are that there is, underlying the* ..*ts processes of nature, a system of mechanical* fferent from the classical laws, expressible by ts in which probably *the quantum-constant h plays* pent part. . But these general equations remain n, and at most all that has been discovered is the tline of the nature of these equations when applied ruous vibrations.

n if the complete set of equations were known, it s no easy task to give a physical interpretation of x to imagine the mechanism from which they s. When the equations themselves are still so ely known this task becomes yet harder, and so little progress has been made in this direction that an attempt to report on it reduces mainly to a chronicle of conflicting opinions.

"The quantum-theory is believed to have disclosed in nature a certain atomicity of a kind unsuspected by the older mechanics. In the form in which the quantum-theory was originally put forward by Planck, this atomicity was in effect an atomicity of energy, although this conception was not exactly used by Planck. But the atomicity was dependent on the frequency of the energy, and seemed to have little or no meaning except in reference to absolutely monochromatic vibrations. It is more natural to suppose that the *real atomicity, if it exists, is that of* the entity measured by $h$, or by some function of $h$ and constants of nature. The constant $h$ is physically of the *dimensions of energy multiplied by time, or action*. But an attempt to imagine a universe in which action is atomic leads the mind into a state of hopeless confusion. The classical equations can be put in the form $\delta A = O$, where A is the action and is supposed to be capable of continuous variation. If A were not supposed capable of continuous variation, but were limited to being a multiple of a unit of action, $h$, it might be possible to construct the true system of equations, including the quantum-theory as a special case. The equations would, of course, reduce to an expression of the principle of least action when the number of units $h$ in the total action was very great and so would also include the Newtonian mechanics as a special case. No progress towards the solution of this general problem has been made as yet. Mention must, however, be made of papers by Sommerfield, in which a theory of an 'element of action,' $\frac{h}{2\pi}$ or $\frac{h}{4}$, is applied to the explanation of X rays, $\gamma$-rays, and the photoelectric effect. These serve to suggest the type of general theory which may, perhaps, be hoped for in the future, but if so, they at the same time indicate how very far the physical interpretation must be from anything at present imagined.

"The quantity $h$ or $\frac{h}{2\pi}$ is also of the same physical *dimensions* as angular *momentum*, so that if we could imagine a state of things in which angular momentum were atomic we might be in the right state of mind for *attempting a physical explanation of the quantum theory*. It is to be noticed that Bohr's theory implies that the angular momentum in an atom with only one electron is always a multiple of $\frac{h}{2\pi}$, and the brilliant agreement of this part of his theory with experiment may indicate that in these cases the angular momentum of the single electron certainly behaves as though it were atomic, but this does not carry us any perceptible distance towards a physical explanation of why this atomicity exists.

"The quantity $hV$, or $\frac{h}{2\pi}$ V, is of the physical dimensions of the square of an electric charge. In point of fact, $\frac{h}{2\pi}V$, *if not exactly equal, is almost equal to* $(4\pi e)^2$; *i.e.*, to the square of the strength of a tube of force binding two electrons. This suggests that the atomicity of $h$ may be associated with the atomicity of $e$. The atomicity of $e$ will not lead to the quantum-theory, otherwise the *quantum-theory would have been fully developed long ago, but there is, perhaps, a hope that the two atomicities* may be special aspects of some principle more general *than either of them. It must be remembered that the* atomicity of $e$ has never received a physical explanation; it is in no way implied in the classical equations of Maxwell, and no reason is known why an *electron* with a charge $\frac{1}{2}e$ should not exist. [Repeated experiments to detect $e$ of a smaller charge have failed]. Any attempt to refer back the atomicity of $e$ to the structure of the ether simply discloses the fact that the fundamental equations of the ether are not yet fully known; it implies that if they were fully known they might be expected to contain the

quantity $e$, and this is perhaps the same thing as saying that they would contain the quantity $h$. It may be that if the equations of the ether were fully known they would be seen to involve the quantum-theory. If $\frac{h}{2\pi}$ V is the same thing as $(4\pi e)^2$, an attempt to give a physical explanation of the quantum-theory might be based on the atomicity and possible discrete existence of tubes of force of strength $4\pi e$, ideas with which we have been made familiar in the writings of Sir J. J. Thomson ("Recent Researches in Electricity and Magnetism," 1892, Chapter I., and later books). These ideas seem to many physicists to be at variance with experience, but they have to their credit that they give a natural and simple explanation of the electro-kinetic momentum in the ether ("Elements of Electricity and Magnetism," 3rd Edn., 1904, p. 279) such as I believe cannot be given by any other series of physical conceptions.

"It may . . . be too early to expect an explanation . . . in fundamental terms of the quantum-theory. . . . Even as regards this preliminary problem there is no general agreement.

"Physically, the quantum-theory undoubtedly centres round the idea of spasmodic or instantaneous interchanges, losses or gains of energy of an amount $\epsilon = h\nu$. This idea involves the conception of two receptacles of energy, but the quantum-theory gives no indication as to what these receptacles are, or when or why they lose or acquire energy.

"In Planck's original theory (*Ann. d. Phys.*, 1901, p. 553) it was supposed that all matter contained large numbers of resonators of different frequencies; these were capable only of holding energy in quanta, and the spasmodic interchanges of energy took place between different resonators. The theory was open to somewhat obvious objections which have been repeatedly urged against it. In the first place, an interchange of energy between resonators of the same frequency does nothing to advance the progress towards the final steady state, while interchanges of energy between resonators of different frequences are in general impossible owing to the incommensurability of the quanta corresponding to different frequencies. This difficulty might be met by supposing that there is some other receptacle for energy, in which the energy is not limited to existence only in complete quanta, as, for instance, the ether or possibly free electrons. This conception, however, is not part of Planck's original theory, and is certainly open to many objections.

"The specific heat formula of Debye implies that in a solid there are no receptacles of energy except the elastic-solid vibrations of the matter and the ether. It would . . . be straining the evidence to conclude that there is no possibility of any further receptacles of energy in matter, but it is significant that Planck's assumed resonators have given no direct indication of their existence. Resonators of infinitely varied frequencies, as assumed by Planck, would imply an infinite variety of atoms or molecules in the solid unless they are of such a scale as to involve relations between different atoms or molecules, in which case they merge into the elastic-solid vibrations of Debye. Resonators of a few definite frequencies are not what is required by Planck's theory, and their existence seems to be put out of question from their not proclaiming themselves spectroscopically.

"Perhaps Planck's original theory seems best capable of coming into line with the known facts of physics if his resonators are definitely identified with the elastic vibrations of the solid. This identification removes one objection which has frequently been brought against Planck's theory. The first part of his proof consists in showing that in equilibrium the mean energy of a resonator must be equal to the mean energy of an ether-vibration of the same frequency. Planck bases this proof on the classical mechanics; in fact, his proof is in essence the same as that given in Section 9 of the present report. Now, it is easy to point out that it is inconsistent to assume, as Planck does in the first part of his
that the energy of the resonators can change contin
according to the classical laws, and afterwards to
that the energy can only change by complete quan
however, the resonators are interpreted simply
elastic-vibrations of the solid, then the equality of th
energies in matter and ether may be treated as an
mental fact; the supposition that the energies ar
is the basis of Debye's theory of specific heat, and
confirmed by observation. The fact that these e
are equal is perhaps (if the classical dynamics
longer valid) a fact which still demands explanati
there is no question that it is a true fact. But
the resonators are indentified with the elastic-vibrati
are no nearer to discovering a mechanism which wil
it possible for the energies to change only by c
quanta—indeed, the proposed identification mak
such hope seem infinitely remote. And it must
noticed that the frequencies of the 'resonators' p
by Debye's elastic-solid vibrations are limited to th
red end of the spectrum, whereas Planck's theory d
resonators of frequencies ranging through the
spectrum.

"In the later forms assumed by Planck's theo
supposed that the resonators emit their radiation i
plete quanta, but that they absorb in it a con
manner. Thus the energy of a resonator at any
may be anything: it is not restricted to being a
multiple of a quantum. This idea is attractive phy
for it minimises the divergence from the older
magnetic theory, and is capable of reconciliation v
undulatory theory of light, but it is questionable w
it is really consistent with the quantum-theory its
the energy of a resonator can vary continuously, w
not deduce the radiation formula from the suppositi
it must be an integral multiple of a quantun
Poincaré's analysis (Section 23) seems to indica
Planck's radiation formula can only be true if the
of the radiation *cannot* vary continuously.

"It may be remarked that Planck's physical t
deal only with one special mechanism of radiation, v
the considerations mentioned in Section 8 of the
report indicate that there must be many mechanism
that each one independently must lead to Planck's f
Thus the physical problem apparently cannot be
by attributing special properties to Planck's rad
what is ultimately needed is a new system of me
which will endow all radiators with these properties

"That this new mechanics must be of a very com
sive nature becomes evident on considering the re
tained in Section 10 of the present report. It was the
that free electrons and ether, interacting according
classical dynamics, would set up Lord Rayleigh's
radiation. It is, therefore, evident that the inte
between the ether and free electrons cannot be go
by the classical mechanics: the new mechanic
differ from the old even as regards the motion
electrons.

"For this reason it seems useless to attempt to
away the conflict between the radiation-laws an
classical mechanics by ingeniously devised special
of atoms, or special detailed mechanisms of emis
radiation, which might seem, while obeying the cl
laws, to give something approximating to Planck'
Any such attempt would first have to surmount th
culty that any system whatever, if it obeys the cl
laws, must also in its state of thermo-dynamical equil
obey the law of equi-partition of energy, which is
in turn to lead to Rayleigh's radiation formula (Secti
And if this difficulty could be turned, as, for instan
postulating a final state which was not one of t
dynamical equilibrium, the question of why all p
mechanisms of radiation lead to Planck's law, as th
tainly appear to do (Section 8), would remain unto
And finally, if single electrons do not obey the cl
laws, there would seem to be little gain in provi

: proved, that complicated structures might possibly .em.

| mechanism of the emission of radiation such as in the line-spectrum of a gas is very clearly l by Bohr's theory, and the marked agreement of :ory with observation certainly raises a strong ption that his premises contain at least some truth. ficult to see how his final equations could stand at *ss it is assumed that the emission of radiation is in* :e quanta, and is an emission of monochromatic Absolutely instantaneous emission is not in any quired, but the emission must be catastrophic in ise that when once it has started nothing can until a whole quantum has been set free.

ain, the whole evidence of the photo-electric effect *in this phenomenon at least, the absorption must* omplete quanta, and, moreover, that the energy of iantum must be in such a concentrated form that .ll be absorbed by one atom.

e whole of the phenomena associated with the m-hypothesis could probably be given a consistent l explanation if we were free to imagine radiation atomic in its structure, consisting of indivisible of radiation, each monochromatic and highly con- ed in space. The quanta might, perhaps, almost ight of as corpuscles of radiation, travelling through vith the velocity of light, emitted and absorbed as te entities, and entirely incapable of any kind of ision. Ideas of this kind constitute Einstein's (see Section 44) of 'light quanta.'

mewhat similar ideas had been formulated before : of the quantum-theory, in particular by Sir J. *mson (see in particular Camb. Phil. Soc. Proc.*, iv., p. 417) who regarded the Faraday tubes [or as having discrete existence in the ether. This f ideas is discussed by Whetham as follows:— lay's tubes, it is clear, give a very powerful and ient method of studying the phenomena of the magnetic field, and indications are not wanting *ey represent something more than a useful mathe-* l fiction. If the structure of the electric field be :inuous in reality, as our tube-picture of it indi- if the electric and magnetic effects of a charge of :ity are in reality exerted throughout the surround- ice by means of discrete tubes of force-vortex fila- in the ether, or whatever they may actually be, an *:ing wave of light must be discontinuous also.* we look at such a wave from the front and magnify ons of times we should see not a uniform field of iation, but a number of bright specks scattered dark ground. Each tube of force would carry its remors, and these would constitute light, but be- them would lie undisturbed seas of ether. Such t about the nature of a wave-front of light is very :cted and surprising. We are inclined at once to :e our tubes of force to a museum of conceptional ties. But it is a remarkable thing that certain ce of the discontinuous nature of a wave-front really cist.'"

(. Millikan says: "In spite of the credentials which ust been presented for Einstein's equation, we are nted with the extraordinary situation that the semi- icular theory out of which Einstein got his equation *to be wholly untenable* and has in fact been pretty illy abandoned, though Sir J. J. Thomson and a few seem still to adhere to some form of ether-string , that is, to some form of theory in which the energy is localised in space instead of spreading over the wave-front. • Two very potent objections, how- may be urged against all forms of ether-string ', *of which Einstein is a particular modification.* rst is that no one has ever yet been able to show ich a theory can predict any one of the facts of rence. The second is that there is direct positive ice against the view that the ether possesses a : structure. For if a static electrical field has a fibrous structure, as postulated by any form of ether-string *theory, 'each unit of positive electricity being the origin* of each unit of negative electricity the termination of a Faraday tube,' then the force acting on one single electron between the plates of an air condenser cannot possibly vary *continuously* with the potential difference between the plates. Now in the oil-drop experiments [Millikan] we actually study the behaviour in such an electric field *of one single isolated* electron, and we find, over the widest limits, exact proportionality between the field strength and the force acting on the electron as measured by the velocity with which the oil drop to which it is attached is dragged through the air. When we maintain the field constant and vary the charge on the drop, the granular structure of electricity is proved by the discon- tinuous changes in the velocity, but when we maintain the charge constant and vary the field the lack of discon- tinuous change in the velocity disproves the contention of a fibrous structure in the field, unless the assumption be made that there are an enormous number of ether strings ending in one electron. Such an assumption takes all the virtue out of an ether-string theory. Despite then the apparently complete success of the Einstein equation [photo-electric effect] the physical theory of which it was designed to be the symbolic expression is found so unten- able that Einstein himself, I believe, no longer holds to it, and we are in the position of having built a very perfect structure and then knocked out entirely the under-pinning without causing the building to fall. It stands complete and apparently well tested, but without any visible means of support. These supports must obviously exist, and the most fascinating problem of modern physics is to find them. Experiment has outrun theory, or, better, guided by erroneous theory, it has discovered relationships which seem to be of the greatest interest and importance, bu the reasons for them are as yet not at all understood." —The "Electron," pp. 229-250. This looks like a fatal blow to the old lines-of-force conception as re- presenting discrete entities, but, until more is known, it is *not wise to give up hope. If I may make an observa* tion, I do not think that the modern worker scraps hi old tools, so to speak, though he may have to re-forge them as times change. In general, it is on this account that physicists have found themselves in an anomalou position; that is to say, they have provisionally accepted two doctrines which are in direct opposition to each other].

*Referring back to the previous paragraphs quoted by the* way from Whetham's "Experimental Electricity," 1905, p. 107, Jeans goes on to say: "The evidence referred to arose from a study of the ionisation of gases by X-rays. It was noticed that the ionisation was such as would be expected if the X-rays did not spread out in accordance with the undulatory theory of light, but moved with their *energy concentrated as described (see Campbell "Moder* Electrical Theory," 1907, p. 226). It is now believe that the ionisation produced by X-rays is produced by th intermediary agency of β-rays, and this somewhat alters the problem. The question now becomes how the X-rays, if they are not concentrated, can produce β-rays as they do, and the problem really becomes similar to that of the photo-electric effect, discussed in Section 48 of the present report [see CHEMICAL NEWS, 1920, cxx., p. 73]. In any case the phenomena of the production of β-rays by X-rays and the emission of electrons by ultra-violet light both suggest very strongly the possibility of radiation being propagated in the form of concentrated 'atoms' or quanta."

"This, view, however, has been unable to gain accept- ance owing to its obvious conflict with well-established principles of the undulatory theory of light. For instance Prof. Lorentz says:—'Now it must, I think, be taken for granted that the quanta can have no individual and per- manent existence in the ether, that they cannot be regarded as accumulations of energy in certain minute spaces flying about with the speed of light. This would be in contradiction with many well-known phenomena of

interference and diffraction. It is clear that, if a beam of light consisted of separate quanta, which, of course, ought to be considered as mutually independent and unconnected, the bright and dark fringes to which it gives rise could never be sharper than those that would be produced by a single quantum. Hence, if by the use of a source of approximately monochromatic light, we succeed in obtaining distinct interference bands with a difference of phase of a great many, say some millions, of wave-lengths, we may conclude that each quantum contains a regular succession of as many waves, and that it extends therefore over a quite appreciable length in the direction of propagation. Similarly, the superiority of a telescope with wide aperture over a smaller instrument, in so far as it consists in a greater sharpness of the image, can only be understood if each individual quantum can fill the whole object-glass.

'These considerations show that a quantum ought at all events to have a size that cannot be called very small. It may be added that, according to Maxwell's equations of the electromagnetic field, an initial disturbance of equilibrium must always be propagated over a continually increasing space.

'Certainly every one of the objections stated in this short paragraph seems to be insuperable. It may be added, that the question of the indivisible existence of quanta in the ether has been tested directly, or as directly as possible, by experiment.

'If light occurred only in quanta, interference could only occur at a point at which two or more quanta existed simultaneously. If the light were sufficiently feeble the simultaneous occurrence of two quanta at any point ought to be a very rare occurrence, so that all phenomena, such as diffraction patterns, which depend on interference, ought to disappear as the quantity of light present is reduced. Taylor has shown that this is not the case; he reduced the intensity of his light to such an extent that an exposure of 2000 hours was necessary to obtain a photograph, and yet obtained photographs of diffraction patterns in which the alteration of light and dark appeared with undiminished sharpness. In Taylor's experiments the intensity of light was $10^{-16}$ ergs. per cubic centimetre, or about one light-quantum per 10,000 cubic cm., so that if the quanta had been concentrated nothing of the nature of a diffraction pattern could possibly have been observed.

'Thus it appears that there is no hope of reconciling the undulatory theory of light with the quantum-theory by regarding the undulatory-theory as being, so to speak, only statistically true when a great number of quanta are present. One theory cannot be the limit of the other in the sense in which the Newtonian mechanics is the limit of the quantum-mechanics, and we are faced with the problem of combining two apparently quite irreconcilable theories."

Emerging from this study are five paramount deductions:—

1. That the Quantum-Theory may be more acceptable if confined to the spasmodic-emission effects and modified accordingly—should any modifications become necessary.
2. That Atomic Dissimilarity, including whole-number isotopes and isotopes having nth decimal place differences in mass should be considered in the light of spectroscopic phenomena and the quantum-theory—(see 3).
3. That the Decimal-place Mass-values of certain elements (atoms) and their stability as regulated by their energy content should be considered in the light of electromagnetic theory and a development of the Prout Hypothesis therefrom.
4. That the Electromagnetic Multiplication Table and the Scheme of Atomic-structure given hereinabove, as based upon sub-atoms and outsiders (also sub-atoms), should be considered in the light of Dr. Aston's discoveries of whole-number isotopes.
5. That the Eye-Effect, if it can be imitated laboratory, should prove a useful tool for the analysis of complex matter, whilst it seems t strong support, by way of example, to the ex of rotational phenomena as attributed to n electrons.

I think that greater use should be made of Analogies. The following may be taken as an atte this respect, which I believe is in harmony wi general argument:—

It must be remembered that a hammer-blow on a a crude act of violence in comparison with the tr musical waves emitted by the instrument. Pre-sup an aether, or some equivalent mechanism, the a afforded by this illustration is of possible inter elucidating the process of radiation.

| | |
|---|---|
| 1. Bell .. .. .. .. .. | Orbital systems asso with atomic nuclei. |
| 2. Hammer act .. .. .. | Electrons displace chemical action, and caused to strik orbital systems. |
| 3. Musical note emitted .. | Radiant energy (*e.g.*, chromatic light) se into the surrou medium—the aethe |
| 4. Vibrations of the air .. | Vibrations or undul of the aether. |

The important point in this analogy is the o system as the *manufacturing source* of the pheno under consideration; and I think that the analogy in my previous paper (Section 12) taken in conjun with the present one makes it very clear that spasmodic-energy effects are orbital phenomena. Reve the action, and assuming that the electron is expelled an orbit, as in the photo-electric effect, does not imply such an action must represent energy being absorbed the aether in quanta.

It is evident therefore that the two paramount fa are:—

1. Properties of the Electron.
2. Properties of the Electronic Orbit as modified by electric mass of the nucleus, these properties b further modified by the presence of other sin systems and possibly the aether.

NOTE.—The contracted term *electronic orbit* (freque used) should be understood as meaning the system sisting of one or more electrons in orbital motion. orbit cannot cannot have properties, obviously.

(To be continued).

March 13, 1920.

CORRECTION.—Referring to Part I., on p. 182, column, 17 lines from bottom, 1910 should read 1919, just above, *d* should read *b*; also on p. 184, 1st colu in the multiplication table, 2 002 should read 3·002.

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ROYAL INSTITUTION.—On Tuesday next, April at 3 o'clock, Prof. Keith commences a course of l lectures at the Royal Institution on "British Ethnolog The Invaders of England"; on Thursday, April 29, Mr. Campbell Thompson delivers the first of two lectures (1) "The Origins of the Dwellers in Mesopotamia (2) "The Legends of the Babylonians", and on Saturd May 1st, Dr. F. Chamberlain begins a course of t lectures on "The Private Life of Queen Elizabeth." T Friday Evening Discourse on April 30 will be delive by Prof. F. O. Bower on "The Earliest-known La Flora," and on May 7 by Lord Rayleigh on "The Bl Sky and the Optical Properties of Air."

## CHEMICAL SOCIETY ENGLISH.

By T. S. PATTERSON.

ɪʀ some years past I have been greatly irritated by ·bal changes made, without my knowledge or approval, papers of mine published in the *Journal of the Chemical ciety*, and I wish now to describe the Publication Comttee's method of dealing with such matters in the hope it publicity may induce reform.

*In November, 1916, I sent three papers to the* Chemical ciety. Into the M.S. the Editor introduced a number *alterations, some of which I cut out in the slip proof.* the paged proof, which I had specially asked for, eve yng was as I desired, except in two instances. In these ses I made the necessary changes and thought that, s time, the papers would be correct. But in spite of : precautions I had taken I found to my amazement ıeu the *Journal* appeared, that the rejected *editorata* d all been reintroduced along with a tew fresh ones, itirely without my knowledge and, of course, in direct position to my intentions. Thus, for example, a mber of subjunctive forms were cut out and the indicae substituted, not upon any consistent plan, but merely re and there in accordance with the Editor's wayward ıcy, *whilst* of the other alterations made, *that* which noyed me most occurred in two places, where a sentence *mmencing* "*But it was not* . . ." had been changed "It was not, however, . . ." and "But if . . ." ered to "If, however . . .", *apparently* without *any* ȝard to the fact that the sentence immediately preceding each case already contained the word "however" used exactly the same way.

I then wrote to the Editor mildly protesting against the ıatment to which these papers had been subjected. In ; reply I was informed that—

> "It is wrong to start a sentence with 'But.' I know Macaulay *does it, but it is* bad English. The word should either be dropped entirely or the sentence altered to contain the word 'however.'"

ıt no authority of any kind was, or has yet been, quoted r the statement.

To anyone who cares to look into the matter Dr. Cain's *ition is* probably the most surprising *literary obsession* at has ever weighed upon the mind of an editor. I *ımediately pointed out that this use of "But" is quite* ·mmon in, for example, Shakespeare, Milton, Johnson, ımb, De Quincey, Scott, Thackeray, Dickens, Stevenson, merson, Blackmore, Carlyle, Meredith, Ruskin, Swinırne, Jane Austen, E. A. Poe, Sterne, Charles and 'inwood Reade, Augustine Birrell, George Eliot, Matthew ınold, Kingsley, John Morley, Walter Raleigh, G. K. hesterton, A. J. Balfour, Kipling, Macneile Dixon, aintsbury, J. S. Phillimore, and indeed every literary ıthor whose works I have examined. Of scientists whose nglish may be regarded as having authority Tyndall, uxley, Herbert Spencer, P. G. Tait, Lord Rayleigh, ır Edward Thorpe, Sir William Tilden, Sir Oliver Lodge, . F. Frankland, Andrew Gray, Sir H. E. Miers, Sir J. Dobbie, H. E. Armstrong, Sir W. H. Perkin, and /. H. Perkin, Jr., *may be mentioned, whilst* the usage is ɔmmon in the *Proceedings* and *Transactions* of the oyal Societies of London and Edinburgh and in the *hilosophical Magazine.* Estimated by Chemical Society .andards the English of all the authors mentioned is bad," but that of Mr. Balfour,* of Sir Walter Raleigh,* nd of Mr. G. K. Chesterton is simply deplorable. This I thought would convince even the Editor, and there fo the mo nent the matter rested.

About a year later (Nov., 1917) I had another paper ready for publication—the twenty-fourth part of the series to which those already mentioned had be'onged. As I had quite determined that these editorial impert'nences should not be tolerated again, I stipulated, in sending the papers to the Secretaries, that no alteration should be made in it before publication without my express consent. It required the exchange of five more letters before th's *simple* request was comprehended, but when at last the Publication Committee were clear about it they were good *enough to say that it was quite a reasonable one,** *which* in the sequel will doubtless strike the reader as peculiar. The paper was then subjected to "editorial *revision*," and some of the alterations made I put back into their original form. A few days later I received from the Editor a letter in which he said:—

> "*With regard to three sentences in your paper which* you prefer to begin with the word 'But,' the Publication Committee is rather of the opinion that it is not the best modern English to do this if it car be avoided, as in the case under discussion. I am therefore instructed to say that the Committe would be glad if you will refer the point to th Professor of English at Glasgow University, an will abide by his decision."

Apparently the bombardment of authorities to which had subjected the Editor had had some slight effect, fo this letter is not so dogmatic as the previous one, but i seems almost incredible that it should have been necessar to write it at all in view of the evidence I had alread adduced, and also because, one might imagine, even th Publication Committee of a chemical society would hav access to some little collection of works by standar authors, and would be able, unassisted, to *form an opinio* on the point in question. The last part of the letter, itsel *doubtless an example of "the best modern English,"* i strangely ambiguous. It is not clear whether the Com mittee was also going to abide by Professor Dixon' ruling, or whether—as would appear if the words be take literally—only I was to be thus bound.

In any case as Professor Dixon was absent on wa service I referred the matter to him by consulting h published works, and found that he, innocently unawa of the disapproval of the Editor and the Publication Con mittee of the Chemical Society, freely commenced ser tences with the word "But." And since, as I thought, would be absurd to suppose *Professor Dixon likely to giv* a ruling on a point such as this, directly at variance wit his own *practice,*† *I joyfully communicated my discove* to the Committee, feeling that they were sure to b *impressed by finding the authority they themselves ha* invoked so decidedly against them, and thinking, ther fore—although, as it turned out, mistakenly—that it wa unnecessary to ask him to write and tell the Committ that he means his works to be taken seriously. Moreov I explained to them that I had consulted Prof. J. Phillimore, a gentleman who, as is well known, has a ve high reputation as a writer and critic of English, and th he was completely in agreement with me.

But I had underrated the enterprise of the Committe It appeared that they had again taken counsel togetl

* *It is perhaps of interest to mention that Mr. Balfour's* "Theism nd Humanism," in 260 pages of text, contains at least 233 sentences eginning with "But" and 53 with "And." In Sir Walter Raleigh's Style," 128 rather small pages of text contain at *least* 37 sentences eginning with "But" and seven with "And." The ratio is surprisingly lose: one "And" to four "But's" for Mr. Balfour, and to five for ir Walter Raleigh. These appear to be the standard chemical tests r "bad English." (See M. O. Forster, *Chemical World*, 1904, p. 103).

* "I am desired by the Committee to say that if you are allud merely to alterations in the paper after the final proof has left yo hands (*i.e.*, apart from correction of printer's errors) your request in the opinion of the Committee, a reasonable one."—(Letter fro the Secretary, Dec. 10, 1917) "May I again emphasise the ent concurrence of the Committee in the view that, apart from correcti of printer's errors, no alterations should be made in the paper wi out the author's cognisance."—(Letter from the Secretary, Dec. 1917). When I pointed out that "cognisance" is not synonymo with "consent," the Secretary explained (Jan. 7, 1918) that "'cogn ance' *was intended to include 'consent.'* The Committee does choose its own words as carefully as it chooses those of other people

† Professor Dixon has since assured me that this highly origi notion meets with *his entire approval; his precept, it seems, may* inferred from his practice.

and, pathetically helpless, had decided to ask a ruling from another authority whom they approached, either under the impression that the practice of a literary man is no guide to his general principles, or else without having taken the trouble to look at their authority's writings. Had they done so they would have discovered that he adopts freely the usage they so naively asked him to condemn; the second paragraph of the preface to his best-known book—a book about Shakespeare—being an example in point.

In writing to this gentleman the Editor said:—

> "I am aware, of course, that innumerable authors do this and indeed, many authorities such as Macaulay, &c., but I cannot help thinking that good modern writers would avoid it,"

a powerful line of argument perhaps, but rather vitiated by the fact that good modern writers do nothing of the sort. In his reply the authority said:—

> "'But' is only rightly employed when the intention is to bring into very sharp and direct opposition two clauses or sentences,"

so that his ruling was clearly in my favour. He stated that two sentences may quite legitimately be connected together by "But," provided it is desired to bring them into sharp opposition, and, of course, in that case the second must thus begin. Nevertheless Dr. Cain wrote to me:—

> "In view of this (the Authority's) letter, I am instructed to say that the Committee regrets that it cannot agree to the publication of your paper unless the Editor's alterations are agreed to.* They are as follows: 5 sentences beginning with 'But' (pp. 6, 7, 8, 9—two instances). Further, 'corresponding to,' (requires to be altered to 'corresponding with' on p. 9, and 'Firstly' on p. 4, which I had overlooked on my first reading of the paper, should be 'First' (You follow with secondly and thirdly)."

In a PS. the Editor added:—

> "No guarantee can be given that no alteration will be made in a paper after the author's corrected proof has been received. Your paper affords a very good example of the reason of this. The word 'Firstly' was quite innocently overlooked by me in the first reading of the paper. I might have also missed it in reading the slip proof but noticed it in the page proof. Had such a guarantee been given the paper would have had to be held over from publication, the question referred again to you, and if you did not agree, and in consequence perhaps withdrew the paper, the Society would have had to bear the cost of uselessly setting-up the paper."

Comment on this is perhaps scarcely necessary; but it may be recalled that the Secretary, describing it as reasonable, had already, on behalf of the Society, given the guarantee which the Editor now says cannot be given, so that one wonders a little whether it is the Committee that controls the Editor or the Editor who controls the Committee. Further, is it possible to imagine a more farcical state of affairs than that the Editor or the Publication Committee of a chemical society should venture to ban a word which was used absolutely within its proper meaning; which is given in every modern dictionary I have consulted; and which, presumably, is therefore at the disposal of any person who may choose to use it? †

Such then is the Committee's recipe for English. They seem to entertain the belief that, by alterations like these, any mediocre prose can be converted into literature. In any case it appears, incredible though it may seem, that the Committee construed their Authority's letter into a support of their view that it is necessarily "bad Engli to commence a sentence with the word "But," in spit the fact that, as I pointed out to them, he himself stantly did so.*

Thus the Committee had appealed to two Authori and both of these, in the one case indirectly and in other both directly and indirectly, had decided in favour. With becoming modesty I pointed this out, quite in vain. On April 3, 1918, the Secretary w to me:—

> "The present position is simply that the Publica Committee has passed your paper for publica 'subject to editorial revision'—the condition attac to the acceptance of every paper. . . . We our part are ready to publish the paper as soon you agree to the alterations required, but if does not commend itself to you, the only o thing for you to do is to withdraw the paper."

But since the Committee, by their application referees, had induced me to think that, whilst they c sidered themselves incompetent to decide the point their own research, they were willing to accept the *cathedra* utterance of an authority, I had meanw requested a ruling on the subject from two eminent liter men to whom I was personally quite unknown†; s mitting to them the complete paragraphs containing sentences in question, and asking for a definite statem as to whether they really thought it necessarily " English" to commence a sentence with a "But."

Sir Walter Raleigh in his letter wrote:—

> "The statement that in good English no sentence begin with the word 'But' is merely absurd.
>
> "Good English is a very difficult thing to dogma about. If I were now an Editor I should be m more chary than I should have been, say, tw years ago, about ruling out words and usag
>
> "It would be quite easy . . . to recast sentences without the 'Buts.' It would also be q easy to print your sentences as they stand. If the battle that matters, then I think you are good ground."

I sent this letter to the Committee, pointing out h Sir Walter Raleigh considered the Editor's rule to "merely absurd" and that it would be quite easy to p my sentences as they stood they should suffice for *Journal*, but all the Secretary had to say was:—

> "If, as we gather from your letter, you do not see y way to agree to the alterations required by Editor, you are free to exercise the right for wh you stipulated and to withdraw the paper. ' letter from Sir Walter Raleigh, of which I h retained a copy, is returned herewith."

My other referee was Mr. G. K. Chesterton, who in his letter:—

> "My relations with English literature have so far c sisted in reading good books and writing bad or both in alarming quantities. But I confess I can conceive even what is supposed to be the *prima f* case against beginning a sentence with a 'but.' a sentence must contain nothing referring back the last sentence, the objection would apply equ to 'however.' . . . The veto seems to m quite pointless piece of pedantry; and not even scholarly pedantry."

* Another example, presumably, of the "best modern English."

† I may just add here that to keep the issue perfectly simple I confined it to the one question of "But" by withdrawing—*ad hoc*—my objection to the other fatuities.

* It is worthy of remark that the usage is even easily to be fo in the writing of nearly all the members of the Publication Co mittee. No one, however, is likely to blame the Committee ignoring their own practice, whatever it may be.

† I thought this would probably be more acceptable to the C mittee than a belated application to Prof. Dixon, whom, of cour know personally, just as I know Prof. Phillimore, of whose opi

y to this the Secretary wrote:—

.ave yours of the 25th inst., and in accordance with your instructions return the paper and diagrams. Enclosed you will please find Mr. Chesterton's letter.

ur suggestion that the Publication Committee has found your paper unsuitable for publication is not in accordance with the facts. As I have already pointed out, your paper was passed for publication, subject to editorial revision, and the sole reason for its non-appearance in the *Transactions* is that you, unable to accept the Editor's alterations, have withdrawn the paper."

Committee seemed strangely anxious to disclaim ection of the paper; the Secretary insists that the ittee found the paper suitable for publication. But paper were suitable for publication why did the ittee not publish it? The Committee must take my as I send it. To refuse to publish it in that form eject it. Should they see fit they may reject it, venture to think that fair-minded people will expect .o show sounder reason than refusal to observe a English apparently invented by a few chemists for men to break: a rule characterised by Sir Walter as "merely absurd," and by Mr. Chesterton as "a ointless piece of pedantry, and not even of scholarly ry."* To insist upon the observance of such a rule k too much, and should arouse, amongst those who n the *Journal* and whose English is subjected to d of coercion, such an expression of opinion as will e practice instant surcease.

thus we parted. I sent the paper, with a full ex- *on of its rejection by the Chemical Society, to the* Society of Edinburgh, which is a literary as well as tific society. It was accepted with all its "Buts," leed with the addition of a few more, and it stands that Society's *Proceedings*,* showing, amongst things, that it is possible to commence, quite ly, not merely a sentence or a paragraph, but even , with a "But."

artless tale related above will probably astonish ose who know the despotic ways of the Committee, re remains to tell. In the number of the *Journal* 1918, cxiii., 339) which was published next after my had been rejected in the manner just described, ppeared, over the initials W. A. T., an obituary of William James Russell, and in this notice at least tences commence with the proscribed word "But,"† n interesting fact if taken along with the deliberate n of my paper for this same heresy and the state- f the Secretary that the Committee are responsible y word that appears in the *Journal*, and also his for their sweet reasonableness.‡ In the following of the *Journal* (May, 1918, cxiii., 363) Sir Henry ins in a manner that one would have expected to bout the resignation of the Editor, whilst, as I *out at an earlier stage, an obituary notice of* Sir Roscoe by T. E. T. (*Journ. Chem. Soc.*, 1916, cix., o contained flagrant examples of this deplorable n. Now, if I may make a guess at the mystery of ials W. A. T. and T. E. T., these authors are gentle- wide literary experience and culture, and are arly good models in such matters, so that the usage three able writers of English furnishes, one must think, an interesting commentary both on the Committee's view that this practice is "bad English" and on the courage with which they hold their convictions. For "bad English" must be "bad English" whether written by W. A. T., by T. E. T., by *Sir Henry Miers*, or by me. Nevertheless, to tell the shameless truth, I had much rather write the worst of "bad English" in their company than indulge in the very best modern brand painfully excogitated by the Editor and the Publication Committee *of the Chemical Society*.

I have confined myself to this one instance in order to illustrate the procedure of the Committee. It would be easy to add many more, but what I have said will perhaps suffice in the meantime. Chemists are long-suffering people, but it is scarcely to be expected that they will stand indefinitely treatment such as I have described. Some years ago Prof. Armstrong remarked that "the management of our Chemical Society, of late years, has been so unimaginative that everything has been red-taped, and much offence has been given by the inelastic administration of narrowly conceived rules. I speak from experience. My own feelings are so incensed that I would not touch its publication department with tongs; if no other means of publication were open to me I would not publish at all" (*Chemical World*, 1914, p. 68).

Others very probably entertain a similar view. For my own part I shall not again send a paper to the Chemical Society without a previous guarantee that its English—its purely literary form—shall be inviolate, which *means*, doubtless, that nothing of mine will henceforth sully the chaste pages of the *Journal*. This is, I daresay, of little importance in any case; but should my action assist, even slightly, in emancipating my colleagues from an absurd *bureaucracy, it will not have been altogether in vain.* It is for others now to take the matter up, and by steadfastly refusing the editorial alterations so persistently thrust upon them, regain the privilege of expressing themselves in their own natural English, which is quite unlikely to be improved by anything that can be prescribed for it by the Editor or the Publication Committee of the Chemical Society.

Organic Chemistry Department,
University of Glasgow.

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## ENLARGE THE MODERN UNIVERSITIES.

By A. F. SHEPHERD.

ALL psychologists appreciate that the mental faculties of the average youth only become ripe for rapid expansion at the age of adolescence, which, for convenience, can be taken at fourteen or fifteen years; an age when the majority of the nation's youth are expected to leave school. Unfortunately for many, this is just the dawn of mature *understanding. Education before this time is frequently* accepted as a burden to be borne, its "Whys" and "Wherefores" being beyond the range of interested comprehension. It is also the time for the formation of stable character, because the sense of responsibility has commenced.

Secondary schools, in raising, as they have done, their standard of education, have bridged the pupil over to the period of awakening. The longer experience of mental exercise and increased information in this new condition of ripened mind and body inspires in the brightest and best pupils a zeal for fuller and more profound knowledge, which is not deterred by the severer matriculation examinations instituted by the modern Universities.

Now that this wave of enthusiasm is bringing large numbers to the doors of the University, it is imperative that those doors be flung wide, and that the zeal of earnest youth shall not be damped by the despairing words, "No room." It is probably reasonable that the test of entry

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19, xxxix., 18. The sentences in question will be found on , and 28; and also in the CHEMICAL NEWS, 1919, cxviii., 281.

lso *Nature*, March 4, 1920, p. 1, for further examples by the hor; he seems to be incorrigible.

regard to the form of any paper to be published in the *of the Chemical Society*. the last word must rest with the se."—(*Letter from the Secretary, Dec. 21, 1917*).

e same time, may I say that the Committee adopts a very e attitude (!) in these matters, and in case of a difference of s always ready to give full and if possible favourable tion to the author's statement of his case."—(Letter from tary, Dec. 10, 1917).

should be made exacting, as it has been, so as to ensure that only men and women of capacity should take up the time and abilities of gifted professors; but once youth has filled this requirement, the rest should be made easy, for on the selected or super-minds depends the Empire's strength.

It is to its fresh and vigorous youth that the Empire looks for advancement, along the lines of those inventions, discoveries, improvements, and developments that keep it in the forefront of the Empires of the world. It is by the development of such a class that we look for leaders and statesmen, and the permeation of public sentiment with such sound and solid knowledge that unsettling revolutionary, and wildly speculative, methods will be killed at their inception, for unconstitutional acts could never live among a people of whom an important percentage were more completety educated.

In the United States, University education has passed into acceptance as the one essential qualification of men or women seeking to occupy a position involving constructive and administrative ability.

It is contended by some thoughtful people, that had our own country realised the importance of advanced education twenty years ago, Germany would never have possessed such confidence in her superiority, and consequently there would have been no war. On the face of it, the contention is reasonable, as such a nation, holding itself so far advantaged over her strongest possible foe, might easily have suffered from "swelled head."

There is no doubt that as a nation we did not appreciate the enormous part that science would play in the great war. The blunder that sent many of our learned men into the trenches, some to be lost and others to be recalled, is evidence of blindness in this respect. This error of understanding cost us untold wealth and hundreds of thousands of lives, besides placing the Empire in the direst peril.

Yet can it be denied that, in spite of the initial mistake, our men of science turned the scale in the winning of the war? Hastily collected from the trenches, urged to greater pace in workshop and laboratory, backed by all the resources of the State, our skilled chemists and engineers, our men of theory, and men of imagination, made the contributions of applied knowledge that told so heavily and brought about the end.

Equally, can it be denied, that to the cramped stereotyped and inelastic education of some in responsible administrative positions, we owe much of the incohesion and disorder that nearly brought our nation to disaster. The learning that waxed eloquent on the music of ancient verse and was silent in research such as that into aniline dyes, nearly proved a costly curriculum to Britain.

The war taught us that the battle is not mainly to the soldier, but to the scientist and to the versatile mind. The great general depended at every turn upon the skill of men of knowledge. It was the mathematician who timed the advance of protecting curtain fire and measured the fuse of shells, the engineer who devised the tanks and guns, the scientist who winged the aeroplane and dug the trench. It was the neglect of meteorology which cost us many disasters.

And now, in peace times, the captain of industry must turn to the scientist as his chief ally. There is scarcely a trade or calling now but depends upon the skill of chemist, engineer, and mathematician.

Hence the growing need of modern Universities. Unless the nation awakens to the paramount importance of this matter, unless it is ready to encourage and intensively develop advanced education in all practicable directions, in another twenty years we shall be as we were in 1914, a nation on the decline physically and educationally when compared with the advancement of other nations. And who can tell but there may again arise the nation, feeling herself superior; and the happenings of 1914 be repeated, but with different results from those in the recent cataclysm.

## PROCEEDINGS OF SOCIETIES

### PHYSICAL SOCIETY.

*Ordinary Meeting, March 26, 1920.*

Prof. W. H. BRAGG, F.R.S., President, in the C

A DISCUSSION took place on "*Einstein's The Relativity*."

The discussion was opened by an explanatory on the subject by Prof. A. S. EDDINGTON, after whi following contributions were made:—

Mr. BOLTON—Prof. Eddington mentioned that aviator flying at a high speed people on the ground appear contracted in the direction of motion an *versâ*, and appeared to deduce from this that dimensions of the interferometer in the Michelson-I Experiment would be contracted. He did not s connection, as there was no relative motion betwe observer and the instrument.

Prof. EDDINGTON pointed out that the experimen a null result because of this fact; but the mathem had deduced the contraction by imagining himself relative to the æther, and therefore having a v relative to the instrument.

Sir GEORGE LANE FOX-PITT asked if the observ always regarded merely as a seeing person rather t thinking person.

Prof. EDDINGTON said that by "observer" he m person armed with his perceptions and with sci apparatus where necessary to aid him in m measurements.

Dr. H. LEVY said it was difficult to see why of possible tracts which a particle might follow it always elect to follow a geodesic.

Prof. EDDINGTON said one reason for identifyi natural tracts of particles with geodesics was t particle must take a unique tract definable w reference to an observer. The only tract which c defined uniquely in this way is a geodesic.

Mr. T. SMITH asked if light in a gravitational became to any extent polarised.

Prof. EDDINGTON did not think there was any evi of this.

Prof. A. O. RANKINE said, apropos of Mr. S question, that a few months ago in collaboration wi Silberstein he had carried out some experiments o point, the results of which were in the course of pu tion. Silberstein had shown that according to Ein theory a gravitational field should produce an effect c velocity of light polarised in a plane parallel to the The same theory showed, however, that light polarised at right angles to the field would be affect the same extent, and it was desired to test how fa equivalence was in accordance with fact. A be light, plane polarised at 45° to the vertical, was pro in a horizontal direction and examined for ellipticity distance away. It is evident that if the vertica horizontal components travelled at different rates, a difference would be introduced which would re elliptical polarisation. No trace of ellipticity was det the deduction from Einstein's theory being confi Perhaps the most interesting fact emerging fro measurements was the extraordinary degree of pre with which the two velocities were found to be The difference of optical path of the two component certainly less than one three hundredth of a millime the distance travelled in a second, viz., three hu thousand kilometres, assuming a gravitational field to that of the earth to hold over the whole distance.

Dr. VINCENT asked if the theory of Relativity appl the Kinetic Theory of Gases would not oblige us to our ideas on high temperatures. The conclusion probably fallacious, but it appeared at first sight as

could not move with a velocity greater than that , and that consequently there would be an upper as a lower limit to the absolute temperature

EDDINGTON replied that with our usual definition erature as proportional to the energy of the atoms as no upper limit; but if the scale were chosen to not on the energy but on the square of the , it would reach a finite limit.

OSEPH LARMOR, in a communication read by the ty, said the charm of the Einstein train of ideas o be traceable to several causes. In the first place revived the interest in the Riemann differential ry, itself a transcendental development of the ideas Gaussian theory of surfaces, and the admiration of or the train of thought of his disciple is on record. again, as it loosens all foundations, its ideas are of development in unexpected directions. How s from being a determinate theory of the universe pear to anyone who dips into the writings of its ers. Indeed, if it became fixed and rigid and to reveal unexpected vistas, much of the fascina- ould be gone. For example, the crowning con- ion for the most general relativity, on which special s laid by Lorentz, and by Eddington, is the asser- Einstein that it is only the intersections of the ines of particles that can constitute events, and so s these points retain the same order along their ve may give body to their collocation by filling up y kind of intermediate spacial scaffolding that we There is nothing to restrict it at all. Yet for all e proceed straightway to assume a space with its avitational potential functions, and work out its natics in the necessary elaboration; while we learn timately there can really be nothing to limit our of such a frame-work. I observe that Langevin, Frenchman, does not shrink from blunt formula- the full logical consequence. It is therefore pos- says he (Société Française de Physique, Feb. 6, to make enunciation of the principle of generalised ty, in the assertion that the laws of physics have ne form for all systems of reference, in motion (or ation) anyhow, in virtue of the introduction in each f its own special field of gravitation suitably dis- d. The ensuing problem is then to explain how it astronomers, since Newton's time, have persisted special and very precise illusion about the distri- of gravitation, whereas really an unlimited choice en. One answer seems to involve swinging over to posite point of view, to the youthful dogmatism of , that if space could be fully known the whole al universe would be found to be involved implicity it. The general dialectic can thus develope many- and indefinite; the necessary co-ordinating con- ion appears to be present in a somewhat latent te of one space-time continuum, which this un- multiplicity constitutes merely different modes scribing. If we would thus reach at bottom an ying scheme of space and time after the manner wton, why should the natural historical order of pment in terms of an æther be ruled out *à priori*? guiding philosopher for this type of theory is d by Einstein to be Hume filtered through Mach; certainly affords a wider field for the play of his ism than his own illustrations. primary consideration in all sceptical analysis is to where to stop, and, as with Kant in Hume's time, face further destructive criticism by constructive esis. For the unresolvable essence of relativity s to be that we cannot get on without assuming foundation to which phenomena are referred, and spect to which they are ordered to the degree that is ary for our reasonings. as not escaped the notice of the creators of the ical theory that the whole of it is expressible as a ty, of novel type it is true, to the fundamental physical principle of least action, which adopts that principle to take in the phenomena of gravitation so as to place them in analytical relation to the other physical principles of nature. Of the fundamental character of that principle Helmholtz, following upon Hamilton and Kelvin and Maxwell, was not the least of the exponents. The original criteria of stress-energy-momentum tensors then shrink to their proper subordinate position. There is then nothing revolutionary about this brilliant theory, unless it be the fiction that time is merely an additional dimension of space, which is inconsistent with the very language in which it has to express itself, and at variance with the different conditions for physical determination in space and in time. That it is convenient to use mixed co-ordinates of time and space is another matter whose bearings were beautifully elucidated by the application long ago of the expressive phrase *local time* by Lorentz; it is local time varying irregularly from place to place that allows gravitation to come within the least action scheme.

MR. A. W. RAVENSHEAR said that in the Michelson-Morley experiment the contraction of the apparatus could not be measured by measuring rods or anything of that kind. It therefore required reference to some other system of measurement. What was this?

Prof. EDDINGTON repeated that no contraction could be directly measured by this experiment. We are led to expect it on the assumption that the apparatus is moving *relative to the æther. At any moment we do not know* whether we are moving relative to the æther or not; but at some parts of the year we must be, so that if the results of the experiment are always negative we have to deduce the contraction.

A SPEAKER asked how, if curvatures in space only exist round matter, accommodation was found in the theory for the existence of free energy.

Prof. EDDINGTON remarked that energy also had curvature.

*Mr. C. O. BARTRUM pointed out that the Michelson-* Morley experiment compared the velocity of light athwart the æther stream with the mean of the velocities up and down the stream. Had any experiment been made comparing the velocity up the stream with that down the stream, and did Prof. Eddington consider such an experiment was possible? He asked the question because he had seen it stated that the work of M. Q. Majorana had shown these velocities to be equal.

Prof. EDDINGTON said he had heard that statement, but was not in agreement with it. Majorana's work was to show that there was no change in the velocity relative to the observer due to motion of the source or of a reflecting *mirror. He did not think an experiment could be devised* to test the point referred to as it was necessary to determine the times of arrival and departure at the two ends of the path. This could only be done by clocks, and if you use only one, you must correct for the velocity of light, which is the thing you are trying to measure.

Mr. T. SMITH asked if any of the conclusions of the theory would be modified if we were assumed to be dealing with group velocities rather than wave velocities. If he remembered rightly the most accurate determinations had revealed a difference even in vacuum.

Prof. EDDINGTON was unable to say offhand.

Dr. E. H. RAYNER asked what happened if the velocity of a body exceeded the velocity of light.

Prof. EDDINGTON pointed out that a body would require infinite energy to attain this velocity, and so could not exceed it.

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THE LINEN INDUSTRY RESEARCH ASSOCIATION.—The recently advertised positions for Research Chemist and Research Botanist have now been filled by the appointment of Mr. R. Philip Keith to the position of Chemist, and Mr. C. O. Searle to the position of Botanist.

## NOTICES OF BOOKS.

*The Dyeing Industry.* By S. H. Higgins, M.Sc. Third Edition. Pp. viii+189. London: Longmans, Green, and Co. 1919. Price 8s. 6d. net.

The author is to be congratulated on the style which he has adopted in writing this book. Apart from any comments that may be passed, the fact that the book is in its third edition is self laudatory.

The book in its first edition was issued in 1907 as a "Report to the Electors of the Gartside Scholarship of the University of Manchester on the Results of a Tour in the United States of America and Germany in 1905-1906." In 1916 the second edition was published, and the author adopted the title "Dyeing in Germany and America."

The present edition has been brought up to date by several revisions and additions, notably a new chapter on recent progress in the industry, founded on articles published by the author in the Annual Reports on Applied Chemistry issued by the Society of Chemical Industry, 1917-1918, and also a new section on Colour Production.

The book is divided into fifteen chapters, the first chapter giving a general history of the art of dyeing. The following four chapters deal with certain specific operations which are carried out in the art of dyeing. The author's method of dealing with the subjects is to be commended; he commences with a brief *resumé* of the history of the operation and then gives the different methods of procedure now adopted, comparing them one against the other. In the next chapter (VI.), entitled "German and English Flannelettes," the author, after giving an outline of methods adopted in the two countries, compares them.

The following chapter deals with the conditions of life in the industry.

Chapters on "Efficiency in the Industry," "Instruction in Dyeing," "Colour Production," and "Progress in the Industry during the War" are other features of the book. In a brief sketch which the author draws on the research work carried out in the industry the following lines are worthy of repetition:—"There seems to be a public awakening to the necessity for the application of research to industry. . . . It has already been pointed out that it is a great mistake to state that the German dyeing industry is in advance of ours. . . . But this position should not suffice. Now that we have the lead it behoves us to keep it, and research will be one means to that end."

The book is to be well recommended to those who wish to gain a thorough survey of the dyeing industry.

*Limes and Cements.* By Ernest A. Dancaster, B.Sc. (Lond.), A.I.C. Second Edition. London: Crosby Lockwood and Son. 1920.

The author has compressed into 195 pages an immense quantity of important material which will be found useful not only to the beginner but also to those whose daily work brings them into contact with cement and kindred material. He has written it in a manner suited to those who have not had a scientific training, at the same time using phrases used "in the trade" for which explanations are given.

The book is divided into twenty chapters, the first giving a brief outline of the growth of the industry. The author mentions that the Assyrians and Babylonians appear to have employed moistened clay for cementing their bricks together. From this time he traces the history of cementing material through the Egyptians, Greeks, Etruscans, Romans to the 18th century, when James Parker introduced the first of the natural cements which he discovered in the London clay formation off the Island of Sheppey.

From this time rapid strides were made in cement manufacture, both from the practical as well as the theoretical aspect, the pioneers of the latter being Le Ch[...] Michaelis, and others.

Chapter II. deals with the chemistry of lime, wh[...] explained very lucidly. The following two chapte[rs give] a *resumé* of the composition and origin of the rocks [which] furnish different kinds of lime, and the calcination [of the] former for the production of the latter.

The manufacture and composition of mortars, co[ncretes,] stuccos, &c., fill the remainder of the book except [the] last two chapters, which deal with the testing of ce[ments] and limes both by mechanical and chemical means. [Photo]graphs are inserted of the different testing machines.

The book contains a good bibliography, and the [author] mentions in the preface that he has used G. R. Bu[...] treatise on "Limes, Cements, Mortars, &c.," as the [basis] of his work.

*Bismuth, Etain, Plomb.* By A. Bauchonnet. Pp 370 + xii. Paris: Octave Doin et fils, 8, Pla[ce de] l'Odéon. 1920.

When one reads this book one realises the im[mense] amount of scientific research that has been carried o[ut] on the subject of Bismuth and its compounds the [...] covers 88 pages, Tin and its compounds are respo[nsible] for 125 pages, and the remainder (137 pages) is devo[ted to] the discussion of lead and its compounds.

The book forms part of a scientific encyclopædia [which] is being published under the direction of Dr. Tou[...] (Directeur à l'Ecole des Hautes Etudes. The enc[yclo]pædia when completed will contain about 1000 vo[lumes] which it is hoped will rival other dictionaries of chem[istry].

M. Bouchonnet in the present book has gathered tog[ether] and put into a well thought out order a great deal of [infor]mation on the subjects under consideration, and he gives a good bibliography from which such inform[ation] has been extracted.

The general scheme which the author has used follows. He commences with a short history of th[e ele]ment, then to a consideration of (1) the ores, (2) me[thods] of extraction, (3) properties, both physical and chem[ical,] (4), alloys, and so to a consideration of the compoun[ds].

When the amount of substance is viewed which has [been] put into these several classes it is doubtful whethe[r the] author has omitted anything, for he has inserted [com]pounds which are of very rare occurrence.

Unfortunately the book has two bad features: it con[tains] printer's errors, which in themselves are not the aut[hor's] fault, yet it makes the book look bad: the other con[cerns] the author himself—it is in the matter of his che[mical] equations; in at least ten instances they do not bal[ance] and one is led to believe that they are intended to d[o so] for each side is connected with a sign of equality.

When these have been corrected one would hav[e no] hesitation in recommending the book.

### BOOKS RECEIVED.

"Fuel Production and Utilisation." By Hugh S. Tay[lor,] D.Sc. (Liverpool). Pp. xiv + 297. London: [Bail]lière, Tindall, and Cox, 8, Henrietta Street, Co[vent] Garden. Price 10s. 6d. net.

"Laboratory Manual of Elementary Colloid Chemis[try."] By Emil Hatschek. Pp. viii + 135. London[: J.] and A. Churchill, 7, Great Marlborough Street. [Price] 6s. 6d.

"The Analysis of Minerals and Ores of the Rarer [Ele]ments." By W. R. Schoeller, Ph.D., and A[. R.] Powell. Pp. x + 239. London: C. Griffin and [Co.,] Ltd., Exeter Street, W.C. 2.

"A Foundation Course in Chemistry." By J. W. D[odg]son, B.Sc. (Lond.), A.I.C., and J. A. Murray, B[.Sc.] (Edin.). Pp. xii + 240. London: Hodder [and] Stoughton. Price 6s. 6d.

## CORRESPONDENCE.

### CHEMICAL SOCIETY'S NEW BY-LAWS.

*To the Editor of the Chemical News.*

-At the special meeting of the Chemical Society on inst., to consider the new By-laws, it is very able that the interests of those who contribute papers e Journal should be kept in mind. It is therefore to ped that some one will move an amendment to the sed By-law XVI. Hitherto, Part 2, the corre ding section, has read: "All papers communicated to ociety, with their illustrative drawings, shall become roperty of the Society, *unless stipulation be made to ntrary*, &c."; already a sufficiently absurd arrange , but one which at least leaves to an author the power ep possession of that which is his own. It is one of b, for years past, I have invariably availed myself. t the Council is apparently still unsatisfied and pro s to alter this to: "The Society shall have the right to all papers communicated to the Society, with their ative drawings," in order that authors shall deliver selves, even more completely than before, into the s of the officials.

e proposal is a preposterous one, and will, I hope, be ted.—I am, &c.,

T. S. PATTERSON.

versity of Glasgow, April 17, 1920.

## NOTES.

YAL INSTITUTION.—A General Meeting of the mem of the Royal Institution was held on the 12th instant., J. H. Balfour Browne, Vice-President, in the Chair. Chairman reported the death of Mr. C. E. Groves a Resolution of Condolence with the relatives was ed. Mr. F. W. Bain, Dr. C. J. S. Hancock, Sir h Hoskyns, Bart., Mrs. Bayford Owen, Dr. C. pson, Mr. F. C. M. Welles, and Miss Z. M. Woodhull elected members.

ON AND STEEL INSTITUTE.—The Annual Dinner of Institute will be held in the Grand Hall of the naught Rooms, Great Queen Street, London, W.C. 1, Thursday, May 6, 1920, at 6.45 for 7.0 p.m., under residency of Dr. J. E. Stead, F.R.S., supported by Vice-Presidents and Council. At the conclusion of dinner arrangements have been made to carry out a ber of demon-strations, and to display a number of bits of metallurgical interest in the Grand Hall and e rooms adjoining.

HE INSTITUTE OF METALS.—CONCESSIONS FOR DENTS.—The position of students whose course of ies was interrupted by the war, or by special circum ces arising from the war, has been sympathetically idered by the Council of the Institute of Metals. It been decided to recommend for ballot as Student bers of the Institute candidates for election who, st being students of metallurgy, have passed the age of twenty-five years, for admission to Student Mem hip. Students so elected may remain in the category tudent Members up to June 30, 1923, so long as they inue to be students of a recognised school of metal y. This concession represents an appreciable financial ng, as a Student Member pays only the guinea entrance nd guinea subscription of pre-war days. Though in ation for only a few weeks past, the arrangement, we rstand, has resulted in Student Membership applica s being received at the offices of the Institute, Victoria Street, S.W. 1, to a greater number than was ase in the whole of 1919. By a further concession, bers and Students elected at the forthcoming ballot on May 31st will not only have the privilege of member ship for thirteen months instead of the usual twelve, but will receive an extra copy of the *Journal of the Institute of Metals*, of which important publication volumes to the value of over £1000 have been sold to non-members during the past twelve months—surely an unique record for a young scientific society.

THE LEIPZIG SAMPLE FAIR.—The impression gained by a visitor to the Leipzig Sample Fair was that the amount of business transacted will be very disappointing, so far as German industry is concerned. He was confirmed in this belief, apart from actual observation while passing round the various exhibits, by conversations entered into with various foreign buyers and particularly from an exchange of views which took place on the return journey between a Dutchman, a Dane, and a German export shipper. The main theme of this conversation was to the effect that the German industry was absolutely distrusted at the present time owing to (1) the difficulties in connection with obtaining raw materials, shortage of coal, and the upward trend of production costs, and (2) the very questionable tactics which German manufacturers are showing to foreign buyers, particularly as regards the system of accepting contracts with the proviso "freiblei-bend," that is, that the terms are not binding. The Department of Overseas Trade is informed that many orders which were given at the Frankfort Fair held in October last and also at the Leipzig Autumn Fair are still unfulfilled, and there is no prospect of them being carried out at anything like the agreed-upon prices, nor can any satisfaction be obtained from the respective German manufacturers. Some 800 prospective buyers from Denmark attended the Fair, but no contracts appear to have been made, although it is stated that the intention of these buyers was to purchase goods to the extent of one milliard kronen. The outlook had, however, frightened off all prospective purchasers.

## MEETINGS FOR THE WEEK.

*Monday, April 26.*

Royal Society of Arts, 8. (Cantor Lectures). "Aluminium and its Alloys," by Dr. Walter Rosenhain.

*Tuesday, April 27.*

Royal Institution, 3. "British Ethnology—The Invaders of England," by Prof. Arthur Keith.
Institution of Civil Engineers, 5.30.
Royal Photographic Society, 7.

*Wednesday, April 28.*

Royal Society of Arts, 4.30. "Ancient Stained Glass," by Brig.-Gen. C. H. Sherrill, U.S. Army.

*Thursday, April 29.*

Royal Society, 4.30. "The Irish Eskers," by Prof. J. W. Gregory. "The Life History and Cytology of *Synchytrium Endoboticum*—the Cause of Wart Disease in Potato," by Miss K. M. Curtis. "Structure and Affinities of *Acmopyle Pancheri* (Pilger)," by B. Sahni.
Royal Institution, 3. "The Origins of the Dwellers in Mesopotamia," by R. Campbell Thompson.
Institution of Electrical Engineers, 6.
Optical Society, 1.30.

*Friday, April 30.*

Royal Institution, 9. "The Earliest Known Land Flora," by F. O. Bower.
Institution of Mechanical Engineers, 7.

*Saturday, May 1.*

Royal Institution, 3. "The Private Character of Queen Elizabeth," by Frederick Chamberlin.

## NOTICES.

**EDITORIAL.**—All Literary communications, and Books, Chemical Apparatus, &c., for review or notice to be addressed to the Editor.

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IE CHEMICAL NEWS

VOL. CXX., No. 3133.

## HE STRUCTURE OF MATTER AND THE QUANTUM THEORY.

PART III.

By F. H. LORING.

(Continued from p. 196).

POSITIVE RAYS: MAINLY AN ABSTRACT.

SIR J. J. THOMSON's last lecture of the series at the Institution is of great interest. The lecture in- two subjects which I will fully detail under its heads.

ther, to my abstract on the above subject in this il, April 9, 1920, p. 170, it is instructive to recall to Prof. Thomson's statements about $X_3$ (now referred the 3-line and $H_3$) in the following quotation taken one of Prof. Thomson's popular expositions of this t.

ll substances give off gases, chiefly hydrogen and monoxide and dioxide, under such bombardment, mong these gases $X_3$ is nearly always found. The of $X_3$ was for some time obscure, but now I have doubt that it consists of three atoms of hydrogen represented by the formula $H_3$, bearing, in fact, the relation to hydrogen as ozone does to oxygen. reasons for this conclusion are as follows:—It is when we bombard pure substances containing gen, such as ice at the temperature of liquid air, or ammonia at the same temperature; a continuous of it can also be got by bombarding salts containing gen, such as caustic potash. Another very strong is that it can be produced by sending suitable o discharges through pure hydrogen; it is produced, ample, by electrodeless discharges through this gas. d, with very sensitive photographic plates the $X_3$ line nerally be detected when there is a considerable pro- n of hydrogen in the discharge tube used to generate ositive rays. The reason why bombardment with le rays so readily produces the gas is that the secondary rge which substances give off under such cir- ances may be just the right type of discharge to ce $X_3$ when it passes through hydrogen. If kept in rk or free from oxygen, $X_3$ can be kept for a con- ble time; it combines, however, with oxygen if ed to light, or if a strong electric discharge is sent h the mixture; it is not to be found when there is mercury vapour in the discharge tube, so that pre- bly it combines with this gas [in which case one expect hydrides of mercury]; it combines with red- pper oxide, and can pass to some extent through hot ium, though not nearly so readily as in the case of gen itself." This appeared in *Harper's Magazine*,

Aston (*Nature*, March 4, 1920), in continuation of sitive ray experiments, states that the mass of gen is 1·008 and that the molecules $H_2$ and $H_3$ fall oper line, since their masses are evidently found to 16 and 3·024.

foregoing statements do not, however, completely e of the possibility that there may be two kinds of articles, as will be seen from Prof. Thomson's ations in the following abstract which I have pre- from the report of his lecture in *Engineering* of l, 1920.

Referring to the 3-line, Prof. Thomson states that there are some indications that there is another source of this line. On some plates this line shows small differences in its usual appearance.

Prof. Thomson pointed out that the late Lord Rayleigh has shown that the width of ordinary spectrum lines vary owing to the Döppler effect. That is to say, the wave-lengths of lines due to particles moving towards the observer are shortened and the wave-lengths of those moving away from the observer are lengthened, and these differences in speed cause differences in the apparent width of the lines, each line, in fact, being a band. Since the speed of the atom is proportionate to the square root of its mass, it becomes possible by using Rayleigh's formula to calculate the mass from the line-width and temperature.

This Prof. Fabry has done in the case of a line observed only in the spectra of nebulæ, which line is due apparently to a hypothetical element, nebulium. The nebula chosen was one containing *hydrogen and nebulium*, and from the broadening of the hydrogen line Prof. Fabry deduced, by means of the Rayleigh formulæ, the average speed of hydrogen, and knowing the atomic *mass* of this element [not to be confused with the *size* of the atom, as in Bohr's theory, though a difficulty may arise in this case] the temperature of the nebula was obtained. In a similar manner, using the width of the nebulium line as a basis, and knowing the temperature from the hydrogen, as just stated, Prof. Fabry calculated the mass of this substance, which he found to be about 3. Nebulium might, therefore, be an element with this atomic mass, and this element may appear occasionally on the positive-ray plates in addition to a line representing $H_3$ [see Szymanowitz, CHEMICAL NEWS, 1919, cxix., 58; or *Sci. Abs.*, A, 1920, p. 57].

Upon examining the excellent half-tone illustration in a copy of *Engineering* of March 26—previous lecture—Fig. 3, I notice a closely-associated set of lines all of which are numbered on the plate except three.* Two of these lines in question I am taking the liberty to indicate by queries in the list below. There is another line evidently close to 7 in value (if not 7 exactly), which is not numbered. Potassium iodide was the material bombarded.

1 = hydrogen atom.
2 = hydrogen molecule.
3 = $X_3$ = $H_3$ = sometimes nebulium?
[4 = helium?].
[5 = lithium isotope? see in this connection large Table in Part I. of this paper, on p. 183].
6 = carbon of ++ charge.
8 = oxygen of ++ charge.
12 = carbon.
14 = nitrogen.

In the context (returning to the report of the last lecture) Prof. Thomson gives the following lines:—

1·6 possibly due to "atomic grouping."
2·4 obtained from minerals.
3 nearly as strong as the hydrogen line when zircon is bombarded.
3·5 this line also appears when zircon is bombarded —see previous abstract, this Journal, April 9, 1920, p. 170.

Although the positive-ray method of analysis is remarkably sensitive, much more sensitive than the spectroscopic method, there is no need to use pure substances, as each atom or molecule is separated out and contributes to the formation of a parabolic line of its own.

Coming now to the interesting feature of determining the mass of isotopes, it is is well known that there are four species of lead, each with a different mass or atomic

* Examining *other* copies, I find that these lines do not all appear, as might be expected, since they are so faint that it is, of course, difficult to get uniform impressions.—F. H. L.

weight and which are inseparable from one another by chemical methods, whilst the ordinary spectrum of any particular one could not differ from that of any other by more than a small fraction of an Angström unit.

The atomic weights become mean values when an element is made up of isotopic atoms; *i.e.*, those chemically alike but of different mass. [There may be cases amongst the radio-elements in which two lines of disintegration yield products which happen to coincide in chemical properties when they possess atoms of the same mass, in which event they are said to be isotopes, as they would (1) occupy the same place in the Periodic Table, (2) have the same atomic number, and (3) have the same chemical properties].

The positive-ray method gives a separate line on the plate for each isotope [provided the element is one, or the conditions are such, as to produce positive rays at all]. Dr. Aston, working in the Cavendish Laboratory, Cambridge, has made a series of atomic-mass determinations by means of positive rays, using his focus method, and the accuracy mentioned in the report is "1 part in 10,000." Some of Dr. Aston's results are as follow:—

| Element | 1920 accepted at. wts | At. wt of isotopes and the atoms of non-isotopic elements |
|---|---|---|
| H .. .. | 1·008 | 1·008 |
| He .. .. | 4·00 | 4 |
| C .. .. | 12·00 | 12 |
| N .. .. | 14·008 | 14 |
| O .. .. | 16 000 | 16 |
| Ne .. .. | 20·2 | 20, 22, (21) |
| Cl .. .. | 35·46 | 35, 37, (39) |
| Ar .. .. | 39·9 | 40, 36 |
| Kr .. .. | 82·9 | 84 86, 82, 83, 80, 78 |
| Xe .. .. | 130·2 | (128, 131, 130, 133, 135) |
| Hg .. .. | 200·6 | (197, 200, 202, 204) |

The figures in brackets represent provisional conclusions.

Chlorine is a very active element and its two components must diffuse with different speeds; consequently, it might be expected that in allowing the molecules to diffuse through a copper tube of fine bore a compound could be formed which would be enriched with one of the isotopes. [The two allotropic forms of solid ammonium chloride discovered by Scheffer (1915) should, I suggest, be analysed by the positive-ray method].

Prof. Thomson stated that gases exposed for ten years to the action of radium and of course its successive products, show a large quantity of hydrogen which appears as a strong line on the plate. The 3-line is also present. A radium treatment for a few months appears to give similar results. Whether the large quantity of hydrogen present was due to the splitting up of atoms or was due to a liberation of this gas from the walls of the tube could not be answered. [Prof. Thomson does not appear to have mentioned whether a faint $3\frac{1}{2}$ or 7 line was present on the plates of these experiments].

Prof. Thomson states that in making a very careful study of nitrogen, as this element is exceptional, its atomic weight being divisible by 4 with a remainder of 2 [it is interesting to note here that Sir E. Rutherford has apparently separated this "remainder" from nitrogen—see CHEMICAL NEWS, 1919, cxviii., p. 311], he found no isotopes, the mass of the nitrogen atom being 14 within an error of 1 part in 1000. Chlorine isotopes were evidently recorded on the plates, but they were at the time regarded as hydrides. Prof. Thomson, in an earlier lecture of this series, raised the question as to whether some of Dr. Aston's values may not be due to hydrides [the accuracy of Dr. Aston's focus method may help to settle the question of hydrides, as, for example, in the case of chlorine 35+2H the mass should be 37·016 (assuming the formation of a transient compound of this type) and not 37·00—a figure presumably Dr. Aston obtained]. Prof. Thomson remarks on the fa beryllium is exceptional in respect of its atomic we

SIR J. J. THOMSON'S THEORY OF RADIATION: AN ABSTRACT.

Now that the atoms are to be regarded as havin built up with some *unit* material, this circumstar comes of fundamental importance, and the interpr of physical phenomena in one way would include process as a necessary consequence.

In the case of a moving electron its mass is propo to the square of its charge, and this mass is electric. This electric mass is considered to be throughout the space surrounding the electron, but concentration which increases towards the centre electron, becoming very great close up to it.

The amount of this mass per unit volume at any is regarded as being proportional to the square electric force at P. Now the electrostatic po energy at the point P is taken also to be proportic the square of the force ["Mechanical engineers wi as an analogy that in an elastic rod under tensi potential energy per unit volume is $p\,e/2 = p^2/2E$ v denotes the stress, $e$ the strain, and $E$ Young's modu EDITOR of *Engineering*]. Moreover, this potential is equal to the kinetic energy which the mass would p if it moved with the velocity of light. This, Prof. Th thought, was very suggestive, for it implied that wh called *potential energy* might be the *kinetic energy* *mass*, which as stated above was supposed to be buted throughout the whole electric field.

Generalising, it might be supposed that all whether atomic or electronic, has the same origi is in reality due to a diffused mass throughou electric field which surrounds atmospherically all and electrons.

Now the distribution of this atmospheric mass th space is determined by the distribution of the li electric force, and all kinds of energy, whether ki potential, radiant, chemical, or thermal, are of on the same kind, namely the kinetic energy of this which is supposed to be moving with light velocity.

According to this view, when the energy of a s passes from one kind into another, as from *kinetic* *potential*, there is no transformation of fundam energy, but merely the flow of some of this *mass prod stuff* with its intrinsic kinetic energy from one positi space to another under the guidance of the lines of el force. Prof. Thomson is of the opinion that if any of reality were to be attached to the term *energy* transformation from one kind into another would in philosophical difficulties.

Moreover, as a purely mathematical consideratio kinetic energy might be represented as $m\,v^2/_2$, the potential energy as $gX$, these expressions invo no difficulty in the transformation of energy mathematical operations being perfectly valid; bu the other hand, considering energy as something there is a difficulty in forming a physical co of the transformation process and a violatio the principle of continuity seemed to be involved. get over this difficulty Prof. Thomson starts out wit following postulates [the sub-division is mine]:—

(1) That mass is made up of exceedingly small part all of the same kind and very small compared even an electron.

(2) That these particles move with the velocity of lig

(3) That the force exerted on one of these parti either by the electric field or by other particle at right angles to the direction in which the par is moving, so that although the path of a par might be deflected, its energy remains constant

(4) That each of these units has equal mass and e energy, and

That their distribution depends upon the number or concentration of lines of force.

s then assumed that the mass of the particles per volume is equal to—

$$\left(f+\frac{hv}{c}-\frac{gw}{c}\right)^2+\left(g+\frac{fw}{c}-\frac{hu}{c}\right)^2+\left(h+\frac{gu}{c}-\frac{fv}{c}\right)^2 \Big]$$

, and $h$ = components of the lines of force parallel to the axes, $x$, $y$, and $z$.
$v$, and $w$ = corresponding velocities of the lines parallel to the axes.
velocity of light.

rting with the above expression, it is possible to the *usual electromagnetic equations for the tensions* ressures along and at right angles to the lines of force. e particles, though moving with the velocity of light, pt within their small circles of activity by the lines rce which are themselves anchored to the posi- articles and negative electrons of the electrified These exceedingly small particles, therefore, rotate the lines of force with the velocity of light. hen, however, the electrified bodies are moving , the lines of force move too, and might be thrown oops; that is to say, into closed curves without ning or end. These loops in the lines of force are no r anchored, and can no longer hold the particles in These accordingly take the bit between their and move away, carrying with them the closed line ctric force. This they do at their full speed, which velocity of light." *This hypothesis represents the nism of radiation.*

is theory may remind the readers of the CHEMICAL of an idea I advanced in one of my articles in this l, 1915, cxi., p. 301, namely,

know that light is an electromagnetic wave phenomenon, and that it exerts pressure. On very minute particles of matter it may, under certain conditions, exert a pressure greater than gravitational attraction. While this pressure effect does not necessarily contribute to the argument that light is a corpuscular phenomenon (wave motions *are known to give rise to a forward pressure*) the light rays may be vortex rings of energy (atoms) which alternately thread through each other, expanding and contracting, thus giving rise to a periodic phenomenon that may be treated as an electromagnetic wave motion of an all-pervading aetheric medium, which in reality does not perhaps exist as such. It is as if we could take the long drawn-out lines of magnetism of a magnet or coil and weave them into a fabric comprising minute closed-up vortex coils; then as this fabric is manufactured at the light source and hurled out "broadside on," its coils undergo a sort of Brownian movement in threading through each other, expanding and contracting in the process. We certainly could not conceive ordinary matter going through such peregrinations, and in this sense the electro*magnetic mass may be equally removed from* ordinary mass as we experience it. From the study of radiation we might also conclude that light or radiation pulses react on matter, so that action is equal to reaction, otherwise we should have to question the validity of Newton's third law of motion.

also controversial papers in the CHEMICAL NEWS, the same time, on Mass, Weight, and Electrical . That vortex rings will pass successively through other, expanding and contracting in the process, may fully appreciated. *On this view, one might almost* when the elastic limit of a line of force is exceeded, ake away as a closed line with one quantum of travelling out into space as radiation].

Radiation, therefore, consists of mass-producing stuff travelling with the velocity of light and carrying with it closed lines of electric force.

It follows, as a consequence, that the emission of *radiant energy must be accompanied by a diminution in* the mass of the radiating body. This mass-producing stuff, it will be seen, plays a part analogous to the aether, but there are essential differences. The stuff is not uniformly distributed throughout the universe, but it is concentrated in the places where the electric forces are greatest, that is to say round electrons and atoms. "On this view radiation carries, as it were, its own aether, and when there is no radiation passing there is no aether."

The *stuff*, composed of the particles under consideration, involves functions which were discharged separately by matter and by aether on the old view. The *stuff* at one and the same time gives matter its mass and it is the vehicle of radiation. Although the *stuff* is the source of mass and energy it is not the whole of *matter*, i.e. atoms and electrons; nor is it the whole of *radiation*, as the lines of force are an essential part of both and form the *skeleton around which the complete structure is built.* "The ends and beginnings of these lines of force are the places where we localise the electrons and positive particles which build up the atoms and molecules, whilst, in radiation, it is the closed line of electric force which the 'stuff' carries along with it which produces that polarity which is essential for the explanation of the properties of light."

An illustration will make this hypothesis clearer. Assume two oppositely-electrified particles A and B thus—

| A | . . . . . . . . | B |
|---|---|---|
| + | | − |

The mass-producing stuff is distributed round A and B, and from the above equation the stuff would tend to flow from the weak parts of the electric field to the stronger. The weak parts being on the sides of the particles nearest to the right and left margins of the page in the accompanying diagram; and, as a consequence, A would move towards B and B would gain momentum towards A, the two particles thus moving towards each other. Moreover, the stuff would come from the outlying regions of the field, where it is regarded as potential energy, and in settling round the moving charges it would then appear as kinetic energy.

Prof. Thomson believes that along such lines we could get a way of visualising many physical processes and it is an advantage to have some realistic concept of what is happening, and this is more satisfying than mere mathematical symbols; indeed this is recognised by pure mathematicians themselves. "For his own part, the treatment of physical phenomena as merely mathematical problems took away much of its interest."

In conclusion, it was added that the building up of the universe out of lines of force and small particles *rotating* round them with the speed of light represent ideas which are consistent with many of the results obtained by the Theory of Relativity.

In this abstract I have followed very closely the excellent account of Prof. Thomson's lecture as reported in *Engineering*.

It will be seen that this theory has a bearing on the *Quantum Theory*, and it will doubtless be discussed by physicists in due time. It is sufficient to record it here. It should however be noted that Prof. Thomson has always been a strong advocate of discrete lines of force, and the new theory as outlined here is apparently a development of Prof. Thomson's existing ideas about radiation as being intimately bound up with lines of force.

This paper in its entirety involves many subjects, each one of which would afford matter for a paper, but the *phenomena under study are so closely interconnected* I have attempted a somewhat composite treatment which seems necessary.

(To be continued).

ON A
# CONTINUOUS SCHEME FOR PREPARATION OF INDIGOTINE FROM PHTHALIMIDE.

By PHILIP HOLLAND, F.I.C.

In the early months of 1917 my attention was directed to the preparation of ortho-amido-benzoic acid from phthalimide. Consulting text-books at hand I found no mention of the yield, though recovery as copper salt from mother-liquors is described.

In "Watts' Dictionary," vol. i., 752, the author remarks—"The metallic phenylcabamates are little known. . . . The solution of the ammonium salt likewise precipitates the salts of copper, lead, and zinc." A silver salt is formulated, $C_7H_6AgNO_2$—surely a misprint, since silver is a dyad.

The observation led me to prepare the copper salt assumed to be $(C_7H_6NO_2)_2Cu''$. One grm. of "amido" was dissolved in solution of pure soda, which was then just acidified with acetic, diluted to 400 cc. with cold water, and the salt precipitated by slow addition of copper acetate with constant stirring. After two hours repose the upper liquid was passed through a weighed filter, and the apple-green precipitate well washed in beaker with cold water until the filtrate ceased to show colour with yellow prussiate. The precipitate was then collected on filter and dried in water-oven and weighed.

Calculated for $(C_7H_6NO_2)_2Cu''$ an average of six trials gave 99.92 per cent of "amido." An average of three estimations of the Cu in the dry salt gave 18.89 per cent. Theory requires 18.94. If the precipitation be made in the same volume of solution heated to 50° C., the "amido" return is much less, though the solution be cooled to air temperature before filtration.

*The Yield of "Amido" from Phthalimide.*

| | |
|---|---|
| "Imide" crystallised from water.. | 1 grm. |
| Pure soda.. .. .. .. .. .. .. | 2 " |
| Water .. .. .. .. .. .. .. | 10 cc. |

The soda (from Na) was first dissolved, and whilst still warm was put to the "imide" in a 200 cc. flask, and to the solution when clear 10 cc. of a solution of NaClO (5.1 per cent available Cl) was slowly added, and the flask set aside for fifteen minutes. As a droplet on a white plate then gave slight iodine reaction when treated with KI in acetic acid, 1 decigrm. of sodium bisulphite was added before partial neutralisation with diluted $H_2SO_4$ (1 vol. acid to 1 of water). The contents of flask were put in a beaker and just made faintly acid with acetic, diluted to 400 cc., and treated as in previous experiment.

The following percentages for "amido" were obtained:—

91.70, 91.19, 90.60, 91.50, 92.06, 91.38, 91.23, 91.19, 91.38; giving an average of 91.34.

In no case did I obtain the theoretical figure as was to be expected, since some brownish product is formed by the hypochlorite reaction even with pure "imide." Making the above precipitation at 60° C. in a volume of 400 cc. the percentage of "amido" was only 89.7; *i.e.*, 1.61 below my mean.

At this stage of my enquiry it occurred to me to experiment on one of the several schemes for manufacturing synthetic indigo. I selected the one wherein ortho-carboxy-phenyl-amino-aceto nitrile is prepared by acting on "amido" with HCN and HCHO, and then fusing the "nitrile" with NaHO. Took—

| | |
|---|---|
| "Amido" .. .. .. .. | 1 grm. |
| NaCN .. .. .. .. | 1.2 " |
| Technical HCHO .. .. | 2 cc. |

The "amido" in a beaker was dissolved in a minimum of pure soda solution so as to leave it faintly alkaline to red litmus-paper. The NaCN in a flask was dissolved in ice-water and a drop... HCN set free with acid. ...flask, the mixture put to the ... the beaker set aside for two hours. The vo... was found later on to be 50 cc. At the en... there was added 200 cc. of a cold saturated "nitrile," followed by slight acidification to methyl-orange.

The "nitrile" from 1 grm. of "amido ... bulky, and was collected on a 7-inch dried paper of close texture. The washing ... saturated solution. This is necessary sin... water at 13.8° C. dissolves 0.03 grm. of the ... about 0.047 at 18° C. in summer. A slight ... made for the 50 cc. in which the reactio... The filter, with the precipitate, when compl... was laid on folds of blotting-paper, and t... spread over it, and finally dried in oven and retu... weighing tube. An average of ten experiments ... above gave 128.18 per cent of the "nitrile." ... requires 128.46.

For 1 grm. of "amido" in a volume of 40 to 50 ... proportions of cyanide and aldehyde are round abo... given. My technical formaldehyde was reporte... delivered to me to be of 37—38 per cent. Additio... much aldehyde spells failure, as also does over ... and too short a time of repose. The highest figur... ten experiments was 129.0 and the lowest 125.6 p... whilst the fifth of the series was 128.5.

*The "Nitrile" by Continuous Operation from Phthalimide.*

| | |
|---|---|
| Imide.. .. .. .. .. | 1 grm. |
| Pure soda.. .. .. .. | 2 " |
| Water .. .. .. .. | 10 cc. |
| Hypochlorite .. .. .. | 10 " |

Then all operations as before.

The average of twenty experiments gave 117.1 p... of "nitrile" instead of 117.32 based on an "amido ... of 91.34 per cent, my mean from copper salt estim...

These figures tend to confirm 91.34 per cent as th... of "amido" by the hypochlorite reaction.

*Operation Continued to Fusion for Sodium Indoxy...*

Took—

| | |
|---|---|
| Imide .. .. .. .. | 2 grms. |
| Soda .. .. .. .. | 4 " |
| Water .. .. .. .. | 20 cc. |
| Hypochlorite .. .. .. | 20 " |

Then as before, but with 2.4 grms. of NaCN an... of formaldehyde, keeping volume of solution as l... was practicable. After repose, the solution, along ... 20 grms. of added soda, was quickly dried down a... residue put in a nickel crucible and further heate... paraffin bath and stirred so as to remove wate... granulate it. The saline mass was next covered ... melted paraffin and the temperature of the bath gra... raised to 270—275°, which seemed correct. Gentle st... was continued throughout. The further treatment ... yellow melt need not be described. A quite weig... amount of indigotine was finally collected.

It will be apparent that sodi... carboxylate can be prepared o... imide without separating int... by drying down the sodium ... sulphate and adding the ... mono-chloracetate and w... taking care to keep the m... were fused with soda as a... has been said that indigo dire... phthalimide without sep...

In colour factory prac... sumably be first sepa... centrated in vacu... instance, as cor...

'hat their distribution depends and 100 cc. of water concentration of lines of force volatile in steam the ...th final drying for a few then assumed that gallon of mother-liquor would lome is ...ut 17 grms.

...t specifications are, as we know, purposely ... of details. It was just this economy of in- ...spect of the synthesis of indigotine from ...amino-acetonitrile that led to my research. ... lacks completeness in that no mention is ...ld of indigotine. Owing to war conditions ... to get made a suitable fusion pot with ... otherwise it was my intention to make the ...educed pressure. Thus conducted it was ...eld would be good.

... conclusion that organic research is not my ...er. Such attraction as benzene derivatives ... owe to the inspiring influence of Hofmann years that are earlier.

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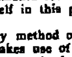
THE

# ...STITUTION OF CARBON SUB-OXIDE.

...y H. STANLEY REDGROVE, B.Sc.(Lond.), F.C.S.

...series of papers published some years ago in the ...ICAL NEWS, which were reprinted in a revised and ...erably enlarged form in my "On the Calculation of ...io-chemical Constants" (Arnold, 1909), I pointed ...at the ignoring of the influence on so-called additive ...o-chemical properties of certain valency-bonds (such ... ethane or C—C bond) vitiated all the results hitherto ...ated for the atomic constants, and, furthermore, ...at the present state of knowledge—these constants ... not be calculated. At the same time I outlined an ...ative method of calculation, making use of certain ...ex constants, which was elaborated in the case of ...o-chemical constants, and successfully applied to the ...imental data obtained by Julius Thomsen. This ...od not only avoided the bond-ignoring error referred ...ove, but also avoided the assumptions made in ...sen's method of calculating the molecular heats of ...tion of organic compounds. It was pointed out that ...onstants obtained could be used to determine the ...itution of new compounds of disputed structure; an ...sting case in point presents itself in that of carbon ...xide.

...ls' formula for this body, namely, O:C:C:C:O, is the ...usually accepted; but it cannot be said that Michael's ...la—



...een entirely ousted from the field. The determina- ...of the molecular heat of combustion of the body—pre- ...ly by the same method as adopted for other organic ...s by Julius Thomsen—would enable the question to ...ally settled once and for all. I was given to under- ...l in a private communication I had from Dr. Diels ... years ago that this determination had been carried ...n his laboratory; but as I have been unable to trace ...published record of this I do not consider myself at ...ty to use the experimental result communicated to me, ...shall confine myself in this paper to the theoretical ...of the problem.

... stated above, my method of calculating physico- ...ical properties makes use of certain complex con- ...ts, referred to as "the fundamental constants," of ...h the undermentioned are required for the present ...ose :—

... = the value of a C atom (see Note) plus that of *four* ...toms and the valency bonds joining them to carbon; ... the value of methane,

$\beta$ = the value of two H atoms and the valency bonds joining them to carbon, decreased by the value of a C.C (ethane) bond.

$\gamma$ = the value of *four* H atoms and the valency bonds joining them to carbon, decreased by the value of a C:C (*ethene*) bond.

$\delta$ = the value of six H atoms and the valency bonds *joining them to carbon*, decreased by the value of a C⋮C (ethine) bond.

$\omega$ = the value of *two* H atoms and the valency bonds joining them to carbon, decreased by the value of an O *atom and two* C.O *bonds*.

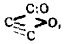
$\omega_2$ = the value of two H atoms and the valency bonds joining them to carbon, decreased by the value of an O atom and a C:C bond.

(NOTE.—By an atom it will, of course, be understood that a grm.-atom is meant).

Or more briefly :—

$$\alpha = C + 4H + 4C.H.$$
$$\beta = 2H + 2C.H - C.C.$$
$$\gamma = 4H + 4C.H - C:C.$$
$$\delta = 6H + 6C.H - C⋮C.$$
$$\omega = 2H + 2C.H - O - 2C.O.$$
$$\omega_2 = 2H + 2C.H - O - C:O$$

Now, *if carbon sub-oxide has the formula O:C:C:C:O*, that is, $3C + 2O + 2C:C + 2C:O$, any additive physico-*chemical property of it will agree with that calculated by* means of the formula $3\alpha - 2\gamma - 2\omega_2$; whereas if it has the formula—



that is, $3C + 2O + C.C + C:C + 2C.O + C:O$, any additive physico-chemical property of it will agree with that calculated by means of the formula $3\alpha - \beta - \delta - \omega - \omega_2$.

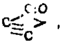
In the case of heats of combustion and formation, the values of the fundamental constants have been calculated by myself from the experimental data of Julius Thomsen (all heats of combustion referring to the bodies in the gaseous state at 18° C., the products of combustion being assumed cooled to this temperature, so that water appears as a liquid, and the results corrected for constant volume, and all heats of formation calculated from these, referring to amorphous carbon and gaseous molecular oxygen and hydrogen), and found to be as under (*op. cit.*).

The plain letters refer to mol. heats of combustion, the dashed ones to mol. heats of formation.

| | | Cals. |
|---|---|---|
| $\alpha$ | .. .. = | 210·8 |
| $\alpha'$ | .. .. = | 21·2 |
| $\beta$ | .. .. = | 52·5 |
| $\beta'$ | .. .. = | 15·0 |
| $\gamma$ | .. .. = | 89·0 |
| $\gamma'$ | .. .. = | 46·0 |
| $\delta$ | .. .. = | 113·0 |
| $\delta'$ | .. .. = | 89·5 |
| $\omega$ | .. .. = | 75·4 |
| $\omega'$ | .. .. = | −7·8 |
| $\omega_2$ | .. .. = | $\alpha'$2 (or 105·4 cals.) (see Note) |
| $\omega_2'$ | .. .. = | −37·9 |

(NOTE.—This is the true value for $\omega_2$, that which it has in the case of carbon dioxide, carbonyl sulphide, carboxy-acids, and their esters. Calculations based on the properties of aldehydes and ketones give different and misleading values owing to the presence of the enol form in such bodies).

Hence, if carbon sub-oxide has the formula O:C:C:C:O, its mol. heat of combustion (under the conditions specified) must approximate very nearly to 243·6 cals., and its mol. heat of formation to 47·4 cals., whereas if its true formula is—



its mol. heat of combustion must approximate to at least 286·1 cals. and its mol. heat of formation to 4·8 cals. at most. (I say "at least" and "at most" here, because the ring formation is liable to give rise to intramolecular strain, and hence to increase the mol. heat of combustion and to decrease the mol. heat of formation).

## A MODIFICATION OF THE THOMPSON METHOD FOR THE DETERMINATION OF ACETIC ACID IN WHITE-LEAD.

By L. McMASTER and A. E. GOLDSTEIN,
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Of the several methods described in the literature for determining acetic acid in white-lead, that of Thompson (*Journ. Soc. Chem. Ind.*, 1905, xxiv., 487) is the most reliable, both for white-leads which have not been ground in oil and for those from which the oil has been extracted.

In this method 18 grms. of dry white-lead are placed in a 500 cc. flask which is arranged for connection with a steam supply and also with a condenser. To the white-lead are added 40 cc. of syrupy phosphoric acid, 18 grms. of zinc dust, and about 50 cc. of water. The mixture is distilled down to a small bulk and steam passed in until the flask is half full of water, when the steam is shut off and the mixture again distilled to the same bulk. This operation is conducted twice. The distillate is then transferred to a special flask and 1 cc. of syrupy phosphoric acid added. This mixture is distilled until about 20 cc. remains in the flask, and steam is passed through the flask until it contains about 200 cc. of condensed water, when the steam is shut off and the liquid again distilled. These operations are repeated until 10 cc. of the distillate require but one drop of N/10 alkali to change the colour of phenolphthalein. The bulk of the distillate is titrated with N/10 alkali, and the acetic acid calculated.

We have used this method to determine the acetic acid in a number of samples of white-lead, but the method is long and tedious, and it is necessary to use a special, rather fragile flask. Thompson states that "if the dry white-lead under examination has been obtained by the extraction as a residue from white-lead paste, it is well that this extraction should be exceedingly thorough, as otherwise fatty acids may be held and distilled with the acetic acid. Even then they will not interfere with the final titration, as they may be filtered from the distillate before titration." In the analysis of a number of samples of extracted white-lead by his method we were never able to get a clear filtrate free from fatty acids, even after long extraction; nor were we able to remove all of the fatty acids by filtration since a great part of them was present in colloidal suspension. The results, therefore, were always somewhat high.

We have found that the time of an analysis can be materially shortened, and the passing over of the fatty acids into the distillate obviated, by performing one initial steam distillation followed by a second distillation under reduced pressure.

The reduced pressure method is as follows:—18 grms. of extracted white-lead are placed in an ordinary 500 cc. flask, arranged for connection with a steam supply and also with a condenser, and 40 cc. of syrupy phosphoric acid (85 per cent) and 50 cc. of water are added. The flask is heated directly and the material distilled d a sma l bulk. Steam is next passed into the flask a distillation continued until about a 600 cc. distil obtained. After adding about 0·5 cc. of the phos acid, the distillate is transferred to a heavy-walled Into the neck of the flask is inserted a two-hole st Through one hole is passed a very small bore ca tube through which a minute stream of air is allow pass during the distillation. Through the other h passed a connecting bulb tube attached to a condenser whole apparatus is so arranged that the distillation m conducted under a reduced pressure of about 150 using an Erlenmeyer filtering flask as a receiver. 10 cc. of the distillate require but one drop of N/10 to produce a colour change in phenolphthalein, th tillation is stopped, the distillate titrated with N/10 and the acetic acid calculated. It is seldom necess distil over more than 500 cc. At no time should the in the distilling flask be allowed to go much below 1 because of the fact that phosphoric acid is often c over by the suction.

We have used the same quantities of materials as used by Thompson so that the two methods cou compared. We found it unnecessary to use the zinc

A series of determinations was carried out by Thompson method and by the reduced-pressure m on a sample of white-lead, made by the old Dutch pro which had been ground in oil. As much as possib the linseed oil was first removed by shaking the white with portions of gasoline until the supernatant liquid no longer yellow on standing with the white-lead several hours. The greater part of the gasoline decanted and the remainder removed by filtration suction. The white-lead was then dried and extr with ether for 72 hrs. by the Soxhlet method.

*Per cent Acetic Acid.*

| Expt. | Thompson method. | Reduced-Pressur method. |
|---|---|---|
| 1 | 0·035 | 0·031 |
| 2 | 0·035 | 0·031 |
| 3 | 0·035 | 0·034 |
| 4 | 0·036 | 0·031 |
| 5 | 0·035 | 0·032 |
| 6 | 0·036 | 0·032 |
| 7 | 0·035 | 0·031 |
| 8 | 0·035 | 0·031 |

Although the results by the Thompson method cl with each other, every distillate was cloudy from f acids in spite of the very thorough extraction; furtherm we were not able to remove all of the fatty acids by fil tion. By the other method, regardless of how clo the initial distillate may have been, the final distillate always perfectly clear and the results obtained are acco ingly slightly lower than those obtained by the Thomp method. If the sample had not been so thoroughly extract there would have been greater differences between resu ts obtained by the two methods, and in a commerc analysis of white-lead such a long extraction is seld made.

We have also used the reduced-pressure method several determinations of acetic acid in white-lead, grou in oil, without first extracting the oil, and find that can obtain results that agree not only with each other l also with those obtained on the extracted sample. It of course, necessary to know the per cent of oil in t sample. Further experiments will be made on this p of the work.

It is thus seen that more accurate results can be obtain by this reduced-pressure method than by the Thomps method. The time necessary for a determination is a shortened and the use of a fragile special flask is unnece sary.—*Journal of Industrial and Engineering Chemist* xii., No. 2.

## CATALYSIS FROM AN INDUSTRIAL STANDPOINT.*

By Dr. E. B. MAXTED, B.Sc.

[CAT]ALYSIS had attained a position of importance in indus[trial] life. An idea of the magnitude of the output of some [of th]e more important catalytic processes might be obtained [by n]oting the figures for the annual production, of, for [insta]nce, sulphuric acid, which even before the war was, [in t]his country alone, of the order of one million tons, [whil]e the industrial development of comparatively recent [proc]esses, such as the hydrogenation of oils and the [synt]hesis of ammonia, was a noteworthy example of the increasing utilisation of catalysis for the foundation [of ne]w industries of the highest importance.

[A] feature of considerable interest in connection with [the d]evelopment of catalysis generally was to be found in [the] manner in which this progress has been made. In [the] absence of general theoretical principles which should [rend]er possible the prediction of suitable catalysts for a [requ]ired reaction, the discovery of new catalytic processes [and] of suitable catalysts had necessarily been made either [by t]he purely empirical method of trial and observation, [exce]pt in so far as the choice of a probable catalyst was [guid]ed by analogy with known reactions. In spite, how[ever], of this unsatisfactory general position catalysis was [beco]ming of ever increased importance both for the mere [acce]leration of reactions which proceed also in the absence [of a] catalyst, and, as what may be regarded as a limiting [case] of this class, for the realisation of reactions [whi]ch do not proceed at all, as far as can be measured, [unle]ss induced by a suitable contact body.

[F]rom an industrial standpoint, in view of the neces[sary] employment of commercial, and therefore impure, [mate]rials, the study of catalyst poisoning is almost of [equa]l importance to that of catalysis itself, especially [sinc]e the large scale development of a catalytic operation [is a]lmost invariably concerned with the recognition and [rem]oval of traces of inhibitive substances, the procedure [adop]ted towards this end being typified by the now classic [wor]k of Knietsch and his collaborators in connection with [the] commercial establishment of the contact process for [the] manufacture of sulphur trioxide. While, however, [the] fruits of this purely experimental study both of cata[lysi]s itself and of catalyst poisons were undisputably [grea]t, it cannot be too strongly urged that the systematic [and] intensified development of catalysis in the future [depe]nds on a better understanding of the theoretical [prin]ciples which underlie the mechanism of the various [type]s of catalytic processes, these principles being not [nece]ssarily the same for every case. Whatever may be [the] exact mechanism whereby a given reaction is [acce]lerated catalytically, many well known examples may [be a]dduced to demonstrate the energetic and intimate [part] which the catalyst plays in promoting the reaction, [its p]hysical form being entirely altered by such participa[tion], by deep-seated cyclic or other changes, at the con[clus]ion of which the catalyst emerges identical chemically [with] the material originally taken. Well-known examples [of t]his are the physical changes undergone by metals such [as] platinum or copper when used for decomposing [amm]onia, or in platinum nets employed for ammonia [oxid]ation.

[A]n example of the purely chemical promotion of a re[acti]on may be found in the part taken by oxides of nitrogen [in t]he chamber process for the manufacture of sulphuric [acid], in which intermediate products may actually be [isol]ated by suitably adjusting conditions. Another [inst]ance of this type of participation is given by the [cata]lytic production of hydrogen by the interaction of [wat]er-gas with steam in the presence of iron.

[A] general theory of catalysis, which shall apply universally to every type of reaction was, in all probability, impossible, and that each reaction, and indeed each catalyst employed for a given reaction, must receive special consideration with the object of setting up certain types of accelerating mechanism, for each of which separate theoretical principles will be involved. This is, he believed, the necessary preliminary step to what from a practical standpoint is the most important task of catalytic theory, namely the prediction of the degree of activity of a catalyst for a required reaction at a given temperature.

As far as concerns catalysis in heterogeneous systems it is obvious, said the lecturer, that whatever may be the exact nature of the catalytic type, catalysis can only proceed provided that the required preliminary association of the catalyst with the reacting system can take place freely. In catalytic hydrogenation reactions all the catalysts usually employed occlude hydrogen to a greater or smaller extent, and it is further to be noted that with any given catalyst, catalytic activity and occlusive power appear to run more or less hand in hand, in that catalyst poisons, such as hydrogen sulphide, not only destroy the activity of palladium but also its power of occluding hydrogen. The platinum metals generally activate hydrogen readily at the ordinary temperature and may well be used for reactions in solvents where the temperature cannot be raised to that required for the base metal hydrogenation catalysts, this low temperature being also conducive to the absence of by-products.

Of all the oxidation catalysts of the first place, added Dr. Maxted, platinum is probably by far the most generally applicable, this metal being employed *inter alia* for the oxidation of sulphur dioxide to trioxide, of ammonia to nitric oxide, as well as, generally, for the catalytic oxidation of organic bodies of the most varied nature in the Dennsteldt method of elementary analysis. It has been shown that the heat of occlusion of oxygen by platinum is of about the same magnitude as the heat of formation of platinum monoxide, but whether or not this oxide is an intermediate product during catalytic oxidation is by no means approved. The second class of oxidation catalysts consists almost exclusively of substances which possess the property of forming higher oxides, which, in order that the catalysed reaction may proceed to completion, must, if they are formed as intermediate products, be unstable under the conditions employed for the reaction, these conditions including the presence of the body to be oxidised. An example of this class of activator is to be found in the evolution of oxygen from bleaching powder in the presence of nickel or cobalt oxides. Cobalt, for instance, forms an unstable oxide possessing the composition $CoO_2$ which may actually be prepared by the action of iodine and an alkali on a cobaltous salt, but which is unstable under the conditions employed for the evolution of oxygen for the reaction in question. Other examples of the class, that is to say, of bodies capable of forming higher oxides than are stable in the presence of the body to be oxidised, are to be found in the use of manganese, cobalt, nickel, lead, or cerium salts for catalytically accelerating the oxidation of linseed and similar oils.

Nitrogen activating catalysts have become of rapidly increased technical importance during the past decade. Iron would appear to be the most generally useful catalyst of this nature for reactions carried out in a temperature region of from 500° to 1000° C. for instance for the synthesis of ammonia and in the Bucher process for the synthesis of alkali cyanides. Iron does not form a nitride directly, although this can readily be obtained by interaction with ammonia. Other examples of nitrogen catalysts, the mechanism of which is not easily understood, is the acceleration of calcium cyanamide formation by calcium chloride and the remarkable activity of osmium for the union of nitrogen and hydrogen.

In conclusion, Dr. Maxted dealt briefly with a point of considerable interest in connection with catalysis generally—the possibility of setting up a standard scale of

* [A] paper read before the Birmingham and Midland Section of the [Soci]ety of Chemical Industry.

activities, on which, for the purposes of reference and comparison, it should be possible to express as a number the observed activity of a catalyst for a given reaction. Catalytic reactions in heterogeneous systems, especially gas reactions in the presence of solid catalysts, do not usually conform to the simple kinetic laws which obtain in homogeneous systems, probably on account of the presence of an absorption layer of variable thickness on the surface of the catalyst, through which layer reaction velocity is influenced mainly by diffusion effects, and for this reason it is not always possible, even for reactions for which the velocity is directly proportional to the concentration of the catalyst, to take the quotient formed by the reaction constant over the concentration of the catalyst, this concentration being expressed as the ratio of the original weight of the reactants over the weight of the catalyst—or some similar relation — under standard conditions, as what may be called the activity number of the catalyst in question. Similarly, the space-time-yield in heterogeneous gas reaction varies enormously not only with the activity of the catalyst but also with the velocity of passage of the reacting gases. If, however, for heterogeneous gas reactions of the nature in which the process is carried out by allowing the gas to pass over a solid catalyst—such reactions forming probably the most important class of industrial catalytic processes — one takes as the activity number at a given temperature and pressure the hourly output of product corresponding to unit weight of catalyst, with a standard space-velocity of gas flow, this last being chosen in such a way that the time of contact with the catalyst is a convenient unit of time, it will be found that a scale can be constructed which should be of considerable utility for the purpose required.

It cannot be doubted that some form of activity scale, to which catalysts can be referred in order to ascertain whether a preparation which is being used has a proper activity, is urgently wanted, but the most suitable and the most widely applicable basis for constructing such a scale is a matter for careful deliberation.

Dr. Brownsdon congratulated Dr. Maxted upon his clear exposition of a most interesting subject.

Prof. Morgan (Birmingham University) said he was much impressed with the view of the author that there was no possibility of any general theory of catalysis. That was very largely his own opinion. He thought the whole subject was too much complicated at present for a general theory to eventuate.

Dr. Slater Price showed that catalysis was largely empirical but not inordinately so; and Dr. Twiss deprecated any tendency in the direction of generalisation in relation to catalysis.

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## NUTRITION AND PHYSICAL EFFICIENCY.*

By E. V. McCOLLUM, Ph.D.
Professor of Chemical Hygiene, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

One of the most awe-inspiring mysteries which the mind of man can contemplate is the power possessed by a tiny mass of matter, the fertilised egg, to develop in a harmonious manner into a composite structure containing tissues and organs with highly specialised functions. Then there follows in all higher animals a period of growth during which the most marked change is an increase in size, but during which there are minor changes in form and structure. No less mysterious is the power of living matter to take from its surroundings food material of a lower grade of organisation than itself, and while undergoing continuous destruction through hydrolysis and oxidation, to utilise this food for rebuilding its structures and m
ing its functional capacity unimpaired.

The full-grown man or animal enjoys a period,
varies greatly in length in different species, during
there is no observable decrease in physical power.
mately, however, the functional capacity of the
diminishes and there sets in a period of involution
is accompanied by changes which we recognise as
teristic of old age.

It is a matter of common observation that the di
types and races of man, living in different parts
world and subjected to widely different climat
engaged in unlike pursuits in order to gain a livel
are not all equals either physically or me
Herbert Spencer once said that "to be a nation of
animals' is the first condition to national prosp
We can all readily accept this view, but on ref
would agree with Lord Rosebery that "an empire
little use without an imperial race."

Various attempts have been made to account f
differences in achievement of man in the several p
the world. Some investigators regard race as the
important factor, and believe that certain race
naturally inferior to others. Huntington, of Yale Univ
attributes to climate the most important role in det
ing the efficiency of man in the several regions
world. Numerous authors have emphasised the i
tance of a satisfactory diet for the maintenance of
and of physical fitness, which all agree forms the
mental basis of achievement. No one up to the p
time has, however, been able to make a very stron
in favour of nutrition as a factor. This is witnes
the number of dietary systems and fads which have
offered to the public. While one enthusiast exto
virtues of abstemiousness, another warns against
points to the high meat consumption of the suc
nations of the earth. While thousands of dysp
adopt vegetarianism, others explain the remarkable l
of centenarians as due to the bacillus of sour milk.

The general public becomes suspicious when appro
by a multiplicity of counsellors seeking favourable
sideration when the character of their advice is bew
ing. The trouble lies in the lack of definite and ac
knowledge concerning the chemistry of nutrition
has prevailed until very recent times. While many
wisest philosophers would agree with the stat
expressed editorially by the *British Medical Journ*
1904, "The study of dietetics should be looked up
very nearly if not quite as important as the study of
peutics," much disagreement would, neverthele
encountered in their views as to the best dietary ha
adopt. Fortunately chemistry has come to rescue die
from its state of empiricism. In the hands of the ch
new methods of experimentation have been deve
which have made possible the solution of proble
detail which were not dreamed of in the philosop
dietitians. Before discussing the relation of the d
man to his well-being and efficiency, I want to expla
simple procedure which has brought order out of ch
the field of nutrition.

The best chemical analysis of a food-stuff whic
chemist is able to make determines the amounts of pr
carbohydrate (starches and sugars), fats and oils,
mineral salts which it contains. For more than th
years it has been known, however, that when a m
of this list of substances, each carefully purified, is f
a young animal the latter cannot grow or long r
alive. The reason for this was very difficult to asce
for it is due to the lack of certain substances of a m
ately unstable nature, the existence of which wa
suspected. Certain species of animal, as the rat, app
require, in addition to the long-recognised dietary
plexes, but two of the unidentified dietary essentials.
most common designation of these is perhaps the
"vitamine," which includes fat-soluble A and
soluble B. No less than twenty-five names have

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* Presented at a joint meeting of the Section of Physics and Chemistry and the Philadelphia Section, American Chemical Society. From the *Journal of the Franklin Institute*, April, 1920.

ited for these substances. Other species of animals, as man, guinea-pig, and monkey, require three, the ional one being called water-soluble C. These s have been applied provisionally pending the dis ty of the chemical natures of these interesting sub- ces.

odern research has shown that there are very great rences in the biological values of the proteins from rent sources. This difference depends on the fact the proteins in different food-stuffs yield varying unts of the amino-acids or digestion products. If the l of the several amino-acids is such as to make possible efficient transformation of food proteins into tissue eins the proteins have a high value. If, however, one more of the amino-acids is present in such small unts as to make it impossible to utilise the more idant amino-acids, they form the limiting factor ch determines the value of the protein in nutrition. y of these digestion products are certainly indispens- in the diet, since they cannot be synthetically pro- d within the tissues. In considering the value of a ral food-stuff or of a diet consisting of a variety of tances, the idea of quality of protein enters into the ilations of the dietitian of to-day.

has been abundantly demonstrated that the mammal ires for satisfactory nutrition nine mineral elements in tion to the essential organic complexes, in order that iet may be adequate. These are calcium, magnesium, um, potassium, chlorine, phosphorus, sulphur, iron, and ne. These can be supplied in the form of inorganic s, except in the case of sulphur, which must be con- ed in the diet in the form of the sulphurised amino cystine. It is doubtful if there is an order of relative ortance among these, for it appears that all are indis- sable. There must be present in the diet either glucose carbohydrate which can be converted into glucose in body. Cane sugar, glucose, beet sugar, and the ches serve this purpose.

seems highly probable that fats and substances ely related chemically to the fats are entirely dispens- in the diet. Up to the present time it has not been d possible to properly nourish an animal with a diet from this class of compounds, because one of the un- tified dietary essentials is associated only with certain . Therefore, in working with a diet made up of puri- food-stuffs, it has been necessary in every case to add of these fats, not because of the fat itself, but because e presence of an unknown substance (fat-soluble A) ch is contained in it.

will be interesting to inquire about the distribution of three unknown substances which the diet must contain. substance fat-soluble A is found in butter fat and egg fats, and in the fats from the interior of the cells of glandular organs of animals (*e.g.*, the liver, the ey) in greater abundance than in any other foods. next foods in importance as a source of it are the es of plants. The seeds, tubers, and fleshy roots are tively poor in this substance.

he water-soluble B dietary factor is widely distributed ng natural food-stuffs. The only foods which are in mon use which are lacking in it are polished rice, the rs and starches, and the fats and oils from both nal and vegetable sources. A group of foods which very poor sources of it are white flour, degerminated n meal, macaroni, spaghetti, and other products pre- ed principally from bolted wheat flour. All whole seed lucts, tubers and fleshy roots, leafy foods, milk and s contain it in relative abundance. Muscle cuts of it are very poor in it, but the glandular organs contain n abundance.

he water-soluble C is abundant only in fresh vegetables, s, and fresh milk from cows which are on pasture. ked and dried foods have in great measure lost their liar dietary properties with respect to this substance.

he effects of specific starvation for one or another of e three substances are of special interest. Each of them is necessary in the diet in order to prevent the development of a specific syndrome which we call collectively deficiency diseases.

One of these, which is caused by a lack of fat-soluble A in the diet, is characterised by a change in the eyes, in which edema, inflammation, and in some cases perforation, are the most important. Much remains to be learned regarding the histology and pathology of starvation for this dietary complex. Without it growth is impossible, and death soon supervenes. There is much evidence that a lack of a sufficient amount of fat-soluble A is one of the factors associated with the etiology of rickets.

A lack, either relative or absolute, of the second dietary factor of unknown chemical nature, water-soluble B, leads to the development of a condition of polyneuritis which in man is known as beri-beri. The paralysis is the most striking general feature of the disease.

The third of the dietary complexes under consideration is the, which prevents when it is present in the diet the development of the syndrome of scurvy. It is the least stable of the three. The antineuritic substance is the *most stable.*

For several years the three substances just discusse have in the popular mind overshadowed in importance the long recognised dietary essentials. It should be emphasised at once that there is no basis in fact for considering them any more important than the proteins or than any one of the essential mineral elements. All are indispensable components of the diet, and are, therefore, of essentially equal importance. Any appraisal of the quality of *the diet must include a consideration of the quality and* quantity of protein; the content of each of the necessary mineral elements; the content of each of the substances which are concerned with the etiology of the deficiency diseases, and the availability of the carbohydrates.

After the factors which operate to make a diet complete and satisfactory were appreciated, a series of studies were carried out with a view of determining the nature and extent of the dietary shortcomings of each of the more important of our natural food-stuffs. In the light of these studies it has become possible to make certain generalisations which are of far-reaching importance in the nutrition of man and animals. On these observations is based a new type of classification of the vegetable food stuffs *depending on the function of the part of the plant from* which they are derived.

It has been found that all those parts of plants which have the functions of storage tissues, viz., the seed, tuber, and fleshy root, have remarkably similar dietary properties and similar shortcomings. Notwithstanding the great difference between the legume seeds, such as the pea and bean on the one hand and the potato or turnip on the other, they have very nearly the same dietary values *in certain respects. All of the cereal grains, legume* seeds, tubers, and edible roots are deficient in some degree in at least three dietary factors. All contain proteins of relatively poor quality; all contain too little of certain mineral elements, especially calcium, sodium, and chlorine, and all are deficient in fat-soluble A.

The leaf of the plant possesses very different dietary properties from the seed. The palatable leaves are alone a complete food for those types of animals which have digestive tracts sufficiently capacious to enable them to eat a sufficiently large amount to meet their energy requirements. This superiority in dietary properties correlates with the special function of the leaf as contrasted with the storage tissue, as the seed, tuber, or root. The *leaf consists of actively functioning protoplasm supported* by skeletal tissue. It is the seat of the synthesis of proteins, carbo-hydrate, and fats. It is the seat of active respiration and metabolism. The seed, tuber, and fleshy root represent on the other hand packages of reserve food materials, with few living elements. In general the structures of the storage tissues do not contain all the complexes necessary for the construction of living protoplasm, and are accordingly incomplete foods.

A similar parallel between function and dietary properties can be drawn in the case of the highly specialised muscle tissue on the one hand and the actively metabolising glandular tissues on the other. The muscle tissue has dietary properties almost identical with the seed, tuber, or root in all respects except its richness in protein. It lacks sufficient calcium, sodium, and chlorine, fat-soluble A, water-soluble B, and water-soluble C. The glandular organs, such as the liver and kidney, are much more nearly complete foods. Indeed, they have all the complexes which are essential for the construction of living tissue, and when supplemented with a carbohydrate, such as starch, approximate much more nearly a complete food than would a similar amount of muscle tissue with starch.

Since there are closely similar dietary properties in the storage tissues of plants and of muscle tissue of animals, it should be expected that mixtures of these even in considerable numbers should not form satisfactory diets. This has been shown in many feeding experiments to be the case. Although it is possible for a young animal to grow on a seed, tuber, root, and muscle cut of meat diet, its growth is never normal in rate or extent. It will always be stunted, and will fall below the normal standard of performance in reproduction and rearing of young, and in span of life.

Consistently unsatisfactory results have been secured on diets consisting of wheat flour, corn meal, rice, peas, beans, potato, turnip, beet, rolled oats, and round steak. The round steak was included to the extent of 10 per cent of the dry matter of the diet.

(To be continued).

# PROCEEDINGS OF SOCIETIES.

## SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

*Ordinary Meeting, April 14, 1920.*

Mr. ALFRED SMETHAM, President, in the Chair.

CERTIFICATES were read for the first time in favour of Misses Dorothy Gertrude Hewer, B.Sc. (London); Rita Catherine Hawkins Johnson; Messrs. Harold Hall, F.I.C.; Geoffrey Trelawney Bray, A.I.C.; Frank William George King; John Robert Stubbs, M.Sc. (Victoria), F.I.C.

A certificate was read for the second time in favour of Mr. Laurence Harry Mills, B.Sc. (Birmingham), A.I.C.

The following were elected Members of the Society:—Messrs. John Carmichael, F.I.C.; Herbert John Evans, B.Sc., F.I.C.; Cornelius Durham Garbutt; Douglas Henville, F.I.C.; Maurice S. Hutchinson, B.Sc.; Benjamin Richards James, F.I.C.; Geoffrey Martin, D.Sc., Ph.D., F.I.C.; Robert Leitch Morris, F.I.C.; James Wood, M.A., B.Sc., F.I.C.

Papers, of which the following are abstracts, were read:

"*The Turbidity Temperature of Fats, Oils, and Fatty Acids.*" (Part I.). By ALBERT E. PARKES, F.I.C.

The author has systematically studied and worked out the influence on the turbidity temperature caused by traces of water and free fatty acids.

He has used as reagents acetic acid and alcohol side by side for comparison, and reference is made to the previous work of Fryer and Weston, and Parkes.

The paper was illustrated by several diagrams and tables, of which lantern-slides have been made.

"*Interpretation of Milk Records.*" By G. W. MONIER-WILLIAMS, M.A., Ph.D., F.I.C.

The author gives a detailed analysis of a serie records obtained in 1915 from a certain farm. content of the morning milk is remarkably low th He discusses the possible causes of this, and con figures with those published by Richmond. He cusses the use of frequency curves in connect milk records, and gives diagrams of the actual f curves of milk records from various sources, sho effect of (1) fat percentage, (2) milk yield on the the curves.

"*The Loss of Free Ammonia from Drinkin Samples.*" By A. F. JOSEPH, D.Sc., F.I.C., an FREAK, B.Sc., F.I.C.

The authors show that in the tropics there is a the proportions of free ammonia in samples of water will rapidly diminish. The ammonia is ox nitrates, but this loss may be prevented by acidif sample, by addition of toluene, or by keeping in indicating that the change is caused by bacterial a

"*A Decanting and Filter-washing Machine.*" SINKINSON, A.I.C.

The author describes this machine, which l constructed to wash precipitates with hot water, washing fluids, expeditiously, and with the great cision possible. Also a decanter to work in con with the filter-washer for the purpose of assis agricultural analyst.

He also describes the method of constructi working in detail, along with a device for auton arresting the mechanism when a precipitate ha completely washed.

# CORRESPONDENCE.

## GAS CAPS.

*To the Editor of the Chemical News.*

SIR,—I wonder whether the enclosed note on Pri periment illustrating the formation of gas ca interest you.

I was pleased to see that Payman has chara Price's experiment as misleading. The flame obta Price undoubtedly possesses many features of a above the reduced flame of a miner's lamp in th gas burning in air in such a manner that the parti gas and air are intimately mixed before combustion, a non-luminous almost solid flame.

The fact that the atmosphere surrounding Price's is pure air, while that surrounding the cap on a lamp is a mixture of gas and air, is of itself ve leading. The heat produced by the combustion per cent of Marsh gas in air is so used up in heati excess of air and nitrogen that the temperature of i of the mixture cannot be maintained except in the of an external source of heat; consequently we conical cap over the lamp flame.

In Price's experiment the mixture of gas and sufficiently rich in gas to enable the flame to burn the continued application of an external source of h

Price's experiment reminds one more of Stev experiments with gas blowers, when he could only ignition of the blowers at certain distances fro points of issue, owing to the velocity of the gas from the blowers.

A simple experiment on the small scale to ill Stevenson's experiments may be obtained by h methylated spirit in a test-tube fitted with a cork narrow glass jet. Ignition of the spirit vapour ma

at the jet or some distance from jet according to the f boiling the spirit.—I am, &c.,

A. E. FINDLEY.

ied Chemistry Laboratory,
University of Sheffield.

## NOTES.

UBER SALT.—His Majesty's Trade Commissioner nnipeg reports the discovery of a lake of solid Glauber r sodium sulphate, occupying about one hundred and containing approximately two million tons, in its raw state is analysed as rather over 95 per sure. The lake is located near Fusilier, Sask, on acombe-Kerrobert branch of the Canadian Pacific ay. The discovery was first made by a man who mployed in drilling for gas in 1918. Some test pits been sunk, which revealed that the depth of the odity ranges from approximately a depth of two feet be edge to eleven feet near the centre. The Depart-of Overseas Trade is informed that a syndicate is eing formed to develop the deposit, for which a con-ble demand is anticipated in the pulp manufacturing try. The following is a copy of an analysis made by vernment official of the Ministry of Agriculture ince of Manitoba):—Anhydrous sodium sulphate, $O_4$ 98·5 per cent; Water, 0·3 per cent; Chlorine, . Matter insoluble in water, 1·1 per cent; total, er cent. This is a very pure sample of dehydrated ier's salt, $Na_2SO_4,10H_2O$.

CANADIAN INDUSTRIES EXHIBITION is being opened Royal Agricultural Hall on June 3 next by the Sir George H. Perley, K.C.M.G., High Commis-for Canada. This Exhibition, which remains open rteen days, consists entirely of Canadian products, ncludes the following industries:—Iron and steel, als, hand tools, transmission machinery, textiles, ng, furniture, provisions, confectionery, leather, and varnishes, brushes, agricultural machinery, tin namel-ware, wood products, animal products, sheet s, rubber goods, footwear, carbides, asbestos, musical ments, building materials, &c. The exhibition is to the trade free, from 11 a.m. to 9 p.m., general 2 p.m. to 7 p.m. Tickets may be obtained on ation to the Manager, 43, Essex Street, Strand, 2.

IADIAN NATIONAL EXHIBITION, 1920.—His Majesty's Commissioner at Toronto reports that the 42nd l Canadian National Exhibition will be held at to from August 28th to September 11th next. This tion affords an excellent opportunity of bringing d Kingdom manufactures to the notice of the Cana-public. Approximately 1,000,000 visitors attended ear's Exhibition. Much interest in the Exhibition is evinced by French manufacturers, who have applied nsiderable space for the display of French products. d Kingdom firms who desire to secure space for an t should apply without delay to Mr. Waters, Cana-National Exhibition, King Street East, Toronto, la. Information regarding past exhibitions may be ed on application to the Department of Overseas , 35, Old Queen Street, S.W. 1.

K CONGESTION AT CONSTANTINOPLE.—The Depart-of Overseas Trade is informed that to relieve the stion which exists at the port of Constantinople, a ulsory sale will take place very shortly of all goods have been lying in the Custom House for more one year and one day. A list of such goods has prepared, and it is stated that the British Chamber mmerce of Turkey and the Balkan States (Inc), Buyuk Tunnel, Han, Galata, Constantinople, is in sion of full information. United Kingdom firms re interested in this matter are advised to communi-with that body without delay.

IMPORTATION OF HEAVY CHEMICALS.—A despatch has been received from His Majesty's Consul at Madrid (Mr. F. Oliver) to the effect that a firm, which has been recently established in Madrid and is closely connected with a well-known French firm, is anxious to obtain quotations from British exporters of the undermentioned heavy chemicals which they propose to import in considerable quantities:—Sal-ammoniac; Bichromate of Soda; Alum Chrome; Alumina Sulphate, 17—18 per cent; Sodium Hyposulphate; Sodium Sulphide, 60—62 per cent; Bleaching Powder, 35—37 per cent; Kaolin. Quotations should be c.i.f. Barcelona or Northern Spanish port. United Kingdom firms who are interested in these enquiries may obtain the name and address of the firm in question on application to the Department of Overseas Trade.

THE FARADAY SOCIETY AND THE NITROGEN PROBLEM. At a recent meeting of the Faraday Society the President, Sir Robert Hadfield, Bart., F.R.S., made public for the first time the important part the Society had taken in 1916 and 1917 in the initiation of the movement which led to the formation of the Nitrogen Products Committee of the Munitions Inventions Department, the monumental Report of which was recently published. The occasion of the announcement was the receipt of a letter of thanks from Sir Graham Greene, Secretary of the Ministry of Munitions, acknowledging the help rendered by the Society and many of its members. The letter states that arrangements are now on the point of being concluded whereby the synthetic ammonia factory which had been partially erected is to be transformed into a commercial project on a very large scale, and many other fixation schemes are under consideration throughout the Empire. It concludes that the Faraday Society will doubtless consider the objects it had in view, in bringing the Nitrogen Problem before the Ministry, have been in great measure achieved.

FUEL RESEARCH.—The Report of the Fuel Research Board of the Department of Scientific and Industrial Research for the years 1918 and 1919 has now been placed on sale through H.M. Stationery Office. The Report deals with the following subjects:—The Immediate Importance of Fuel Economy; Oil Fuel for the Navy and the Mercantile Marine; Description of the Fuel Research Station, and its Functions; Survey of the National Coal Resources from the Physical and Chemical points of view; Work at the Fuel Research Station; Domestic Heating; Air Pollution; Pulverised Coal; Peat Enquiries; Alcohol as Fuel; Gas Standards. It also contains two appendices, "Fuel Economy and Low Temperature Carbonisation" and "Summary of Reports on the Efficiency of Cooking Ranges." The Report may be obtained through any bookseller or direct from H.M. Stationery Office, at the following addresses:—Imperial House, Kingsway, London, W.C. 2; 28, Abingdon Street, London, S.W. 1; 37, Peter Street, Manchester; 1, St. Andrew's Crescent, Cardiff; 23, Forth Street, Edinburgh; or from E. Ponsonby, Ltd., 116, Grafton Street, Dublin. The price of the Report is 1s. 6d., or by post 1s. 8½d.

SULPHURIC ACID FACTORY IN MONTEVIDEO.—By a Law of July 12, 1918, the Uruguayan Government were authorised to negotiate a loan of 100,000 pesos for the establishment by the Institute of Industrial Chemistry of a sulphuric acid factory. A site and building was acquired in Montevideo for some 38,000 dols., and the remainder of the funds has been spent on adapting the building for the purpose mentioned and on the installation of the necessary plant. A further 30,000 pesos is now required before the factory can commence operations, to cover the cost of apparatus for the manufacture of hydrochloric and hydrocyanic acids, for which orders have already been placed with European firms, and for the purchase of raw materials, the remainder to be applied as floating capital for the working of the factory. The Department of Overseas Trade is informed that a project has been submitted for the consideration of the General Assembly with a view to increasing the original loan to 130,000 pesos. The

Law of 1918 above referred to also authorised a credit of 32,000 pesos from the general revenue for the establishment of experimental factories for the production of caustic soda, alcohol, and ammonia. By a Resolution published in the *Diario Oficial* of February 7th, the Institute of Industrial Chemistry is authorised to take 5000 pesos from the sum mentioned in order to meet urgent obligations contracted in connection with the sulphuric acid factory, pending authorisation for the extension of the 100,000 pesos loan.

## MEETINGS FOR THE WEEK.

*Monday, May* 3.

Royal Society of Arts, 8. (Cantor Lectures). "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758—1837," by A. T. Bolton.

Royal Institution, 5. (General Meeting).

*Tuesday, May* 4.

Royal Institution, 3. "British Ethnology—The Invaders of England," by Prof. Arthur Keith.

*Wednesday, May* 5.

Royal Society of Arts, 4.30. "A Photographic Research Laboratory," by C. E. Kenneth Mees.

Society of Public Analysts, 8. "Estimation of the Age of *Ink in Writing*," by *C. Ainsworth Mitchell*. "Estimation of Chinese Crude Camphor," by E. R. Dovey. "Studies in Steam Distillation—The Volatility of Isomers," by H. Droop Richmond and L. R. Ellison.

*Thursday, May* 6.

Royal Society, 4.30. "The Aerodynamics of a Spinning Shell," by R. H. Fowler, E. C. Gallop, C. N. H. Lock, and H. W. Richmond. "Elastic Properties and the Plastic Extension of Metals," by Prof. W. E. Dalby. "Lightning Discharges and on the Electric Field of Thunderstorms," by C. T. R. Wilson. "The Supply of Energy to Atmospheric Eddies," by L. F. Richardson.

Chemical Society, 8.

Royal Institution, 3. "The Legends of the Babylonians," by E. Campbell Thompson.

*Friday, May* 7.

Royal Institution, 9. "The Blue Sky and the Optical Properties of Air," by the Rt. Hon. Lord Rayleigh.

*Saturday, May* 8.

Royal Institution, 3. "The Private Character of Queen Elizabeth," by Frederick Chamberlin.

ERRATA.—In "Chemical Society English," p. 197, the following corrections should be made:—P. 197, col. 2, the end of first footnote is a comment by the author, and should not appear as a quotation. P. 199, col. 2, at end of article, the words "the Editor or" should be deleted. *In the letter on p. 203, "Part 2" should read "part of."*

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3063, December 20th, 1918.
3064, January 3rd, 1919.
3066, January 17th, 1919.
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3069, February 7th, 1919.
3070, February 14th, 1919.
3073, March 21st, 1919.

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E CHEMICAL NEWS

VOL. CXX., No. 3134.

## E STRUCTURE OF MATTER AND THE QUANTUM THEORY.

### PART IV.

By F. H. LORING.

(Concluded from p. 207).

NOTES.

E the *Twenty-sixth Annual Report of the Committee ic Weights* is now to hand (see *Journ. Am. Chem.* arch, 1920, p. 327), the following excerpt from the hould be of interest in connection with the tabular shown on p. 183 cf Part I. of this paper.

. van Laar (*Journ. Chim. Phys.*, 1919, xviii., p. lies a method of *critical constants to the deter-* of the atomic weights of several elements, using sity data of various experimenters, with the fol- esults :—

| | | | |
|---|---|---|---|
| H = | 1·00770 | S = | 32·060 |
| He = | 4·000 | Cl = | 35·460 |
| C = | 12·001 | Br = | 79·922 |

N = 14·004 "

er reliable value, 79·924, for bromine, being the of several selected values (CHEMICAL NEWS, 1920, 40) should, I think, be noted, as van Laar's value upported by those selected by the Committee.

ferring to the scheme, there is a pronounced amongst the first thirteen elements to have veight fractions which give rise to small deviations

1. Whole numbers.
2. Quarter numbers.

g all those 1920 atomic weights greater than which are given to the second place of decimals g C, O, N, and F, that stand out as a distinct re is a tendency for the fractions to give rise to viations from *whole* numbers, and to fall round numbers and *half* numbers. The following values om the 1920 Table show this tendency :—

-0·06+0·07+0·10)/4 = 0·067.

-0·20+0·25+0·32+0·33+0·37+0·37)/7 = 0·28

-0·45+0·46+0·57+0·63+0·68)/6 = 0·53

-0·84+0·88+0·92+0·92+0·92+0·93+0·94+0·96 ·0·97)/10 = 0·91.

parison may now be made with the values of the cheme shown :—

| | Scheme. | Experimental. |
|---|---|---|
| | 0·067 | 0·067* |
| | 0·22 | 0·28 |
| | ( — . | 0·53 not counted) |
| | 0·93 | 0·91 |
| ge .. | 0·41 | 0·42 |

method of comparison is somewhat elastic and it course a rigorous treatment, but it tends to show that there should be values round 0·50 in the scheme when it is extended. Possibly a ½ value should be considered also, but at the *present time* there are no decimal values in the seventies—amongst the determinations given to the second place of decimals.

This procedure is not devised to prove that the scheme *is a sound one*, but when all the figures are taken into account, there is some evidence that the decimal part of atomic weights should *tend* to fall into certain sets or become distributed, and, from this and other considerations, *that the atomic weights should not all be whole numbers, the whole-number values being in all probability those of the isotopes themselves*—apart from a set of non-isotopic* elements which have negligible fractions.

It must be admitted that the above decimal figures can be arranged in other ways than here shown and different results obtained. For example, introducing a "½ set" by "trimming" from the other sets of figures gives a more uniform result, so that the respective average values 0·07, 0·25, 0·46, 0·77, and 0·93 can be obtained. This general method seems, however, suitable in view of the values given in the tabular scheme, but it should not be construed to indicate that all the atomic weights should only have four or five definite decimal magnitudes. The fundamental process implied by the scheme may be involved in *all* atomic weights, while *modifying factors evidently give* rise to variations as indicated by the decimal fractions deviating from certain values, *e.g.*, 0·07, 0·22, and 0·93.

It is understood that the Committee does not claim that the tables issued periodically are prepared with a view to furnishing information for specialists (see CHEMICAL NEWS, p. 40, cited above). The original papers should be consulted; but for the purpose of a general comparison the above values should suffice.

3. The scheme has not been extended beyond phosphorus, as some irregularity appears to have occurred between P and K, the atomic weight of the latter element being quite regular. It looks, therefore, as if either the proportion of isotopes necessitated by the scheme at this point had been modified by some subsequent cause, so that the original proportions are not representative in the present mean experimental values; or that more than two species of atoms become evident at certain places (see CHEMICAL NEWS, 1920, cxx., p. 142). The chlorine isotopes, 35 and 37, *fall* into line in respect of their mass magnitudes.

4. Referring to the tabular scheme and the values given on pp. 205 and 206 of Part III., it would appear that the 3·5- or 7 line is due to Li, the 21-line is due to Na, and the 39-line is due to K.

5. I think that the scheme gives a clear explanation of the reason why so many elements approximate to whole numbers, especially amongst those of smaller mass. For example, with unity outriders, which when cubed of course equal unity, the mean mass values must be close to whole numbers. The non-isotopic elements which evidently did not in a sense pair or associate, namely, C, N, O, and F, add materially to the number of elements having integer atomic weights.

6. In studying the scheme it will be seen that in one respect oxygen would be slightly more regular if represented thus:—$4 \times 4 = 16$. Furthermore, in calculating the mean values of the isotopic sets the decimal fractions appearing in the multiplication table have been neglected, since the fractions are so small they would not appreciably affect the results shown.

7. The question of more than two species of isotopes per element has been under consideration. In this journal (1915, cxi., p. 181), referring to a possible secondary-loop system, it was stated that "such a loop might in places describe the same paths as the one illustrated, and consequently involve the additional evolution of elements similar to those shown."

8. With regard to the electrical conductivity of the

* Exact agreements of this kind are of course accidental.

* Second-order isotopes are not under consideration in these notes

elements, as possibly conditioned in the direction of greater conductivity as the relative proportion of higher mass isotopes decrease, according to a tentative rule already stated (see CHEMICAL NEWS, 1919, cxix., pp. 14 and 62) aluminium has by this rule the highest conductivity of any of the metallic elements of the scheme, and this is experimentally true. Other elements, though having equal isotopic proportions, have different electrical conductivities, but this may partly be accounted for by some form of chemical association amongst the atoms. For instance, silicon may have its atoms more bound, and its electrons in consequence may be less free than in the case of magnesium (see CHEMICAL NEWS, 1919, cxix, p. 199).

9. Referring to the symbols $H_1$, $H_2$, &c. (see p. 184) these are used in a specialised sense, as is evident from the context. H might be clipped to distinguish the sub-atoms thus:—$H_1$, $H_2$, $H_3$, $H_4$.

10. Referring to the multiplication table on p. 184, the following formulisation might be considered:—

$$1+\left(\frac{\sqrt{1-\frac{1^2}{4^2}}}{1}\times 0{\cdot}008\right)=1{\cdot}00793=H_1$$

$$2+\left(\frac{\sqrt{1-\frac{2^2}{4^2}}}{2}\times 0{\cdot}008\right)=2{\cdot}00374=H_2$$

$$3+\left(\frac{\sqrt{1-\frac{3^2}{4^2}}}{3}\times 0{\cdot}008\right)=3{\cdot}00203=H_3$$

$$4+\left(\frac{\sqrt{1-\frac{4^2}{4^2}}}{4}\times 0{\cdot}008\right)=4{\cdot}00000=H_4$$

It will be seen that 4 becomes a limiting constant, very much as *c*, the velocity of light in a vacuum, is the constant in the Relativity equations.

11. It must be understood that *all* these schemes and hypotheses discussed are *tentative*, and if peculiarities are found which cannot be reconciled with experiment, it simply denotes that further work on the problem is necessary. It would appear that the structure of matter has its origin in the atom just as the acorn gives rise to the oak, and consequently the study of the atom is very important; and also, the other side, perhaps best represented by the word *radiation*, is equally important, and this links up the *structure of matter with the quantum theory*. The question, therefore, naturally arises, when considering the structure of matter, *Can any light be thrown on the unsolved problem of valency?*

The tabular scheme is suggestive in this connection, as by assigning a valency of two to sub-atomic helium and valencies to the outriders proportional to their mass, certain values are obtainable, as for example,

| | |
|---|---|
| Li, B, F, Al, and P, | = 1,3 |
| Be, C, O, Mg, and Si | = 2,4 |
| Nitrogen | = 2 |
| Neon | = 0 |

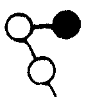
In getting these values, in the case of neon a closed-ring structure has to be assumed. Taking boron as an example (see diagrams), this will show the linking-up of the sub-atoms, the black ones representing the outriders.

*Higher-mass isotopes.*

α

β

*Lower-mass isotopes.*



γ

δ

It is of course understood that the atom would materially from these conventional arrangements e they should represent part of the truth. Ordinary hy having valencies of 1 *and* 3 is a disturbing elemen existing valency schemes. Nitrogen in this case a valency of only *two* units, is equally radical, alt it would explain the inertness of this element; a account of such considerations these relations d appear to illuminate the subject, but one can see the possibility of the *latent* valency of hydrogen brought more into activity when it functions as a atom or an outrider, as appears to be the case with to helium, so that there may be something in these tions worth considering, especially with a view of de ing the ideas along some such lines as indicated. In hydrogen may function in this tri-valent capacity in compounds. It must be remembered too that iso atoms mean isotopic molecules, and with a varie species the vapour density determinations some become doubtful values in interpreting formulæ. again, the question of mixed *association* has to be sidered. The following will make these sugge clearer.

According to the tentative valency scheme given the following combinations are possible:—

| | |
|---|---|
| $B_\alpha$ 1 valency unit. | $B_\gamma$ 1 valency unit. |
| $B_\beta$ 3 valency units. | $B_\delta$ 1 valency unit. |

Now, in the case of $B_\alpha$ one hydrogen atom could con with this atom leaving two unsaturated valencies, assu hydrogen to be truly tri-valent; or, on the other h should hydrogen have only one unit valency in this there would be no free valencies, and this seems in bable from what follows. It would seem to imply $B_\alpha H$ could be isolated as a fully saturated compoun that the tri-valency of hydrogen in this case is unreasonable.

Extending the principles involved and assuming for every $B_\alpha H$ molecule $3B_\beta H_3$ molecules are formed summation becomes—

$$B_\alpha H + 3B_\beta H_3 = B_4H_{10}.$$

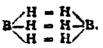
This particular scheme involves assumptions ur ported by direct experiment, *but if these molecules sh be isotopic and more or less associate as implied by free valencies involved, there is no valid objection ag this form of argument from experimental evidence. deed, this probability is implied by the tabular sc itself.*

So far, only higher-mass atomic isotopes have utilised, these predominating in a ratio of 27 to 1. consider that for every set of 27 B's in the above mixture one boron atom (the lower-mass isotope) c bines with one hydrogen atom so as to make up the c plete set of 28 B's, and that the 3 to 1 ratio is still m tained. Then the following result obtains accordin these tentative views:—

$$\left.\begin{array}{l} 9B_\beta H_3+3B_\alpha H \\ 9B_\beta H_3+3B_\gamma H \\ 3B_\beta H_3+1B_\delta H \end{array}\right\} = B_{28}H_{70} = B_4H_{10}.$$

In the experiments of Stock and his co-workers B has apparently a real existance in the vapour state, 

nsity has been found to be 13·97. Considering now a ite single *association*, this molecule would be repre- ed thus:—



this discussion it should be realised that the unit ncy of the hydrogen atom is based upon assumption h breaks down completely in the case of $H_3$. In um tubes transient compounds are formed, such as $CH_2$, $CH_3$, &c., and in these instances there must be ing as well as free valencies, so that in the case of $H_3$ must be at least two binding valencies per atom possibly one free valence per atom as well. That *all* ncy differences = 2 is probable, therefore H must be d 3, not 1 and 2.

. It should be realised that the atoms as herein con- ted have differing *configurations*, and probably the ibution of force in these structures must be taken into ideration in evaluating molecular types or species, the combinations of sub-atoms and atoms may thus rmine the stability of the resulting compound. These iderations should possibly lead to a comprehensive ry of passivity, and, indeed, throw light on catalytic on as well. In radio-activity the root-principle of nistry is revealed, and it should be given in the *first* ter in chemistry, not in the last. That eventually nistry will have to be reconstructed with the atom- cture as the foundation is quite evident.

. The following literature should be consulted in ection with the subjects discussed in this paper:—

steen. "Molecules and Molecular Theory," 1895, p. 159.
dberg. *Zeit. Anorg. Chem.*, 1897, xiv., p. 66.
mstock. *Journ. Am. Chem. Soc.*, 1908, xxx., p. 683; or CHEMICAL NEWS, 1908, xcviii., p. 178.
itherford. *Phil. Mag.*, 1911, xxi., p. 669; 1914, xxvii., p. 488.
arkins. *Phil. Mag.*, 1915, xxx., p. 723.
ddy. CHEMICAL NEWS, 1913, cviii., p. 168.
aufmann. *Göttinger Nachrichten*, Nov. 8, 1901.
ohr. *Phil. Mag.*, 1915, xxx., p. 394; *Sci. Abs.*, A, 1919, p. 470.
ock and co-workers. See *Ber.*, 1914, xlvii., p. 3115; *Abstracts Chem. Soc.*, 1915, 1914, 1913.
rebore. *Phys. Rev.*, 1919, xiv., p. 440; or *Sci. Abs.*, A, 1920, p. 159.
ewis. "System of Phys. Chem.," vol. iii., Quantum Theory (1919).
ans. *Chem Soc. Journ. Trans.*, 1919, cxv., p. 865.

. conclusion, I hope that the readers of the CHEMICAL S will find this paper of interest quite apart from my studies, as I have tried to record some of the experi- tal and theoretical work which is destined to play an rtant part in chemistry and physics in the near future. views recorded are not all in harmony, but none the interesting in consequence.

---

OYAL INSTITUTION.—A General Meeting of the Mem- of the Royal Institution was held May 3; Sir James bton-Browne, Treasurer and Vice-President, in the ir. The Chairman reported the death of Dr. Rudolph sel, and a resolution of condolence with the relatives passed. It was announced that the Duke of thumberland, President, had nominated the following lemen as Vice-Presidents for the ensuing year:— J. H. Balfour-Browne, Mr. W. A. B. Burdett-Coutts, Donald Hood, Earl Iveagh, Sir Charles Parsons, James Reid, Sir James Crichton-Browne (Treasurer), Colonel E. H. Hills (Secretary). Sir John Cadman, de Lara, Mrs. Duncan Mackinnon, Hon Lady ons, Lieut.-Col. W. T. Raikes, D.S.O., M.C., Mr. cus Samuel, and Mr. R. E. Thomas were elected nbers.

## PHOSPHORUS IN HEMATITE IRON: ITS EXACT DETERMINATION AND COMMERCIAL IMPORTANCE.*

By N. D. RIDSDALE (Middlesbrough).

MOST iron ores and pig contain from 0·1 per cent to 0·2 per cent titanium and sometimes more. Recent analyses of different brands of hematite iron show:—England—North East Coast (8 different brands) from 0·10 per cent to 0·42 per cent Ti; West Cumberland and Lancs. (5 different brands) from 0·08 to 0·30 per cent Ti. Scotland—(3 different brands) from 0·12 to 0·18 per cent Ti.

As was pointed out by Pattinson as far back as 1895 (*Journ. Soc. Chem. Ind.*, pp. 443 and 1022), "Even small quantities of this element seriously retard the precipitation of small amounts of phosphorus (estimated as ammonium phospho-molybdate."

### *Titanium not Separated.*

It has been the Author's experience that when no special precautions are taken to remove titanium, longer methods generally show low on account of some phosphorus and titanium being rendered insoluble on evaporation and remaining with the silica, in addition to the retarding *effect of titanium on the phospho-molybdate precipitation*, whereas the "direct" precipitation without evaporation methods to some extent have compensating errors.

Hence the only method hitherto regarded as sufficiently accurate for titaniferous material containing under 0·1 per cent phosphorus involves *double* fusion with sodium carbonate.

### *Cupferron Method.*

*Preliminary Experiments.*—Having noticed that cupferron (ammonium nitroso-phenyl-hydroxylamine), $C_6H_5.N(NO).ONH_4$, was said to precipitate titanium, &c., in strongly acid solutions, it was thought that titanium might be separated from phosphoric acid by this means, and experiments were accordingly made to verify it. Based on these data the "Long Fusion Method" was considerably altered and simplified so as to *remove* the need for any fusion for separation of the titanium.

The details of the revised process are as follows:—

### *Cupferron Method for Hematite Iron Ores or Iron.*

Four to 6 grms. of sample. Dissolve as usual in nitric and hydrochloric acids, remove silica, &c., by evaporation, recover phosphorus from silicious residue by treatment with hydrofluoric and nitric acids and fuse the residue, extract and add to the main solution. Reduce and separate arsenic as usual as sulphide or by volatilisation as bromide or chloride, and separate the phosphorus (and titanium) from the bulk of the iron salts—as described by Blair and others—by oxidising one or two decigrams of the iron and precipitating it as basic ferric phosphate by means of ammonia in dilute acetic acid solution. Wash well *four or five times to remove practically all the* ferrous salts. The phosphorus in this precipitate is separated from the titanium by means of "cupferron" as follows:—

Open out the filter and rinse the precipitate back into the beaker, using a fine nozzle. Add just 25 cc. of warm hydrochloric acid (s.g. 1·16), poured over the filter to dissolve off the remaining traces of precipitate, and allowed to drain into the beaker. Heat till solution is complete, and dilute to 100 cc. (± 10 cc.). Add 2 or 3 cc. bromine water to oxidise all the iron, and boil two or three minutes to remove excess bromine.

Cool to 15°—20° C., and add cupferron solution (6 per cent aq.) drop by drop, whilst stirring, till a further addition to the supernatant liquid only produces a milkiness and no more brown precipitate of iron or titanium nitroso-

* Cleveland Institution of Engineers, Feb. 9th, 1920.

phenyl-hydroxylamine, then add 2 or 3 cc. in excess. Ten to 15 cc. are usually enough.

Shake for about a minute. Filter through a 9 c.m. paper of fairly fine texture, and wash with a cold mixture of 10 cc. hydrochloric acid (s.g. 1·16) per 90 cc. water; receiving filtrate in a 600 cc. beaker marked at 100 cc. About 9 small (10—15 cc.) washes are usually sufficient.

Add 10 cc. nitric acid to oxidise the filtrate and evaporate rapidly down to the 100 cc. mark. If the solution should remain slightly cloudy add a few cc. bromine water, and boil a few minutes.

Lift off the hot plate, add 2 or 3 cc. of ferric chloride solution to indicate the neutral point, and then ammonia till ferric hydroxide is formed. Boil and just clear with nitric acid, add 5 cc. of ammonium nitrate solution (600 grms. per litre); boil; lift beaker off the source of heat and precipitate the phosphorus by adding a mixture of 15 cc. concentrated ammonium molybdate solution (150 grms. per litre), poured into 10 cc. of nitric acid (s.g. 1·42). Shake about two minutes, allow to settle for two to ten minutes, and wash with 0·1 per cent aq. potassium nitrate as usual, and titrate with N/6·72 sod. hydroxide and nitric acid. (See *Proceedings Cleveland Institute Engineers*, 1919, iv., 162 and 163.)

*Concentration Method.*

*Preliminary Experiments.*—Meantime, in spite of only partially successful results in the past to precipitate phosphorus in the presence of titanium by concentration of the nitro-molybdate reagent, it was decided to investigate further in this direction since a big advantage would be obtained if successful. The idea, in general, was to get all the phospho-molybdate carried down—even if contaminated with arsenic, silica, &c., and then to re-dissolve and re-precipitate it pure. The use of compressed reagents—which are being increasingly employed to facilitate analysis—is found particularly helpful in this method, in which success is largely dependent on readily maintaining very concentrated solutions.

The details of the process finally adopted are:—

Phosphorus in hematite iron containing titanium up to about 0·75 per cent (or possibly higher) and arsenic up to about 0·15 per cent.

To 5 grms. of the sample in a covered 500 cc. tall form beaker, add a mixture of 37 cc. of nitric acid (s.g. 1·42) and 25 cc. of water and heat gradually to avoid frothing over. After about ten to fifteen minutes, when violent action has subsided, add one tablet of ammonium acid fluoride (1 grm.) and shake the beaker for one or two seconds. The liquid will froth up at first during the initial action of the hydrofluoric acid generated, but soon subsides on simmering gently. After a few more minutes the metal should be completely decomposed and all the phosphorus in solution.

Cool the liquid to 15°—25° C. and transfer to a 70 cc. measuring flask, rinsing in with a wash-bottle of cold water fitted with a fine nozzle, and dilute to the mark.

Stopper and shake vigorously for about one minute, filter through a deep-ribbed 3-in. funnel through a dry multi-folded English paper. Pipette 42 cc. (=3 grm. sample) of the filtrate into a 300 cc. tall beaker marked at 50 cc.

Cover the beaker; heat to boiling; add one tablet of potassium permanganate (0·25 grm.), and simmer gently two minutes to complete the oxidation of the phosphorus compounds to ortho-phosphate.

Destroy the excess maganese oxides with one tablet containing ammonium oxalate (0·4 grm), ammonium nitrate (10 grms.) and ammonium chloride (4 grms.). This also introduces the necessary ammonium salts.

Simmer about two minutes after the solution has cleared; add 18 cc. concentrated nitric acid (s.g. 1·42), and as soon as the solution boils remove the cover—without rinsing—lift the beaker off the heater and precipitate the phosphorus contaminated with more or less arsenic, silica, &c., by pouring into the middle of it, whilst swirling it, 30 cc. of concentrated ammonium molybdate (150 grms. per litre, faintly ammoniacal).

Agitate vigorously for a full two minutes and th the liquid to stand at atmospheric temperature fo than five minutes.

Filter preferably through filter paper pulp, rins nitric acid water (20 cc at 1·42 s.g. per litre of w give four or five further small washes (10—15 or just sufficient to remove iron salts, &c. Wit return the pulp to the same beaker and rinse th with hot water, using a fine nozzle.

Re-dissolve the yellow precipitate by heat 10 cc. of ammoniacal citrate (water 950 cc. ammonia (s.g. 0·880) 50 cc.; citric acid 25 grms.) to the 50 cc. mark on the beaker and boil a minut Remove from the source of heat and re-precip phosphorus—free from arsenic, &c.—at about 6 adding 50 cc. of cold (12° to 18° C.) ferric-nitro-m reagent, and agitating for two full minutes and to stand five minutes as before. If the arsenic about 0·05 per cent this period of standing shoul exceeded.

Filter—preferably through pulp—wash once w acid water then with potassium nitrate solution a with standard N/6·72 sodium hydroxide and N/6 acid as usual. 1 cc. = 0·0002 grm. P.

If it is desired to weigh the phospho-molybda after the pulp holding the first yellow precipitate returned to the beaker and digested with am citrate, it must be poured on to a small pulp f washed with hot water, using a fine nozzle. T filtrate is then evaporated, if necessary, to the 50 and the phosphorus re-precipitated as just descr is then estimated gravimetrically as usual.

*Ferric-Nitro-Molybdate.*—The ferric nitrate for be bought as such, but unless its quality and iron is known, it is better to dissolve 62·5 grms. of iron or mild steel—below about 0·03 per cent ph and arsenic—in a mixture of 375 cc. nitric acid (s and 75 to 150 cc. water; boil off red fumes; boi three minutes with about 1 grm. of potassium pe nate, and clear with about 1·5 grms. ammonium and evaporate down to about 300 cc. or until the turns muddy, indicating removal of free acid. Ad nitric acid (s.g. 1·42) and heat till clear, th 260 grms. ammonium nitrate, and when dissolved whilst stirring, 650 cc. ammonium molybdate (150 grms. per litre). Heat to 80° C. and agitat minutes. On standing ten minutes all phosphoru is thrown down. Cool, dilute to 2½ litres, a through a dry paper before use. These operat really very simple.

Some of the results obtained by both the "Cu and the "Concentration" methods are shown in panying Table, varying amounts of titanium and being present.

The approximate time required by an oper customed to the methods is:—

"Cupferron" method .. 2½ to 3 hours per tes
"Concentration" method 1 hour ten minutes p

*Overcoming Disagreements in Commerce.*

To merely record two new analytical process enough. It is the sincere desire of the author to further than this, and to offer a practical solutio to obtain close analytical agreement between t and seller.

Looking back over the past ten years, through having no common standard of comparison to wo using different methods—some quite unsuitable— with regard to reducing discrepancies in hematite has been very slow, and there is every justific concluding that nothing short of the *voluntary* of a standard method and a standard analyse which all can employ will produce the desired res

nethods described are offered in the hope that they : guides towards agreeing on a suitable standard which may win its universal approval by sheer

rder to accomplish anything effective it will be ry for those approving of the scheme to come for-nd elect from their midst a small active committee mists to investigate methods and report to the y a process for general adoption. This committee have to investigate new processes and recommend ements from time to time.

author is convinced that those willing to act along nes will soon show by results that their efforts are ntly worth while.

| Type of sample | Titanium. | Arsenic. | Phosphorus. Standard figure. | "Cup-ferron" method. | "Concentration" method. |
|---|---|---|---|---|---|
| No. 1 | 2. | 3. | 4. | 5 | 6. |
| | P.c. | P.c. | P.c | P.c | P.c |
| ed hematite ore .. .. | ? | ? | 0·016 | 0·016 | (a) |
| d hematite ore .. .. | — | — | 0·021 | 0·020 | (a) |
| anish ore.. | 0·12 | Nil | 0·026 | 0·026 | (a) |
| anish ore.. | 0·12 | Nil | 0·026 | 0·027 | (a) |
| est Coast iron "C".. | 0·1 | ? | 0·024 | 0·022 | — |
| itish Chem. Stand. iron "A".. .. | 0·05 | 0·04 | 0·049 | — | 0·049 |
| itish Chem. Stand. iron + 0·10 per cent As .. | 0·05 | 0·14 | 0·049 | — | 0·051 |
| itish Chem. Stand. iron + 0·48 per cent Ti .. | 0·53 | 0·04 | 0·049 | 0·048 | 0·045 |
| 'est Coast iron "B" + 0·32 per cent Ti .. .. | 0·45 | ? | 0·022 | — | 0·021 |

(a) Not applicable to ores.

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## ON WATER FROM THE ROOTS OF RED MALLEE (*EUCALYPTUS OLEOSA*).

By THOS. STEEL, F.L.S.

se for drinking purposes of the water or sap which : obtained from the roots and stems of plants en described by many observers. Eyre mentions ependent he was on this source of supply obtained aboriginals of his party, in the course of his famous y along the Great Australian Bight, in 1841 tral Expeditions into Australia," i., p. 350). Mueller to the copious store of water in the roots of the e ("Fragments," ii., p. 57). Cairns has some in-ng observations on the same subject (*Trans. Phil. Vict.*, iii.). In the course of a lengthy paper cts of Forest Vegetation on Climate," *Journ. Roy. I.S. Wales*, x., pp. 179—235), Rev. W. B. Clarke ons the occurrence of such water and its use by inals and others. Magarey, in a valuable paper in a great deal of information is gathered, details a number of Australian plants which are of value in nnection, and which, in parts of the interior where is scarce or absent, enables the aboriginals to exist *Aust. Assn. Adv. Science*, vi., 647).

numerous other works mention is made of this : of supply of drinking water, but I have been unable to find any adequate report of a chemical examination. Doherty gives a partial analysis of a sample from a species of *Vitis* growing at Tweed River, New South Wales, in which he found 39 grains total solids per gallon, of which 11 grains were inorganic, and 28 grains organic, chiefly tannin (*Rep. Aust. Assn. Adv. Science*, vii., p. 345). This is equivalent to 55·8 parts total solids, of which 15·7 are inorganic, and 40·0 tannin per 100,000.

At the meeting of this Society in September, 1918, Mr. Fletcher exhibited specimens of water-storing roots of the Red Mallee (*Eucalyptus oleosa*), and of the water obtained therefrom, which had been sent to him from Fowler's Bay, South Australia, through the good offices of Messrs. G. Murray, T. Gill, C.M.G., and H. S. Crommer. Mr. Fletcher kindly gave me the water for chemical examination, and I desire to thank him and the gentlemen named for the opportunity of conducting so interesting an investigation.

When the water is freshly extracted, it is stated to be colourless and practically without taste, and furnishes a cool refreshing drink. It is obtained by cutting lengths of the roots and allowing them to drain into a vessel. When the tightly-corked sample reached me it had been in the bottles several months, and had a pale brown colour, which darkened considerably soon after the bottles were opened. When I examined the sample it had a slight flavour, resembling that of water in which leaves had been soaked or that from a peaty source, but was quite palatable. It was neutral to litmus. The figures in the table give the results of the analysis. For comparison I have put in the average of a number of representative analyses of soil waters obtained by Morgan at Michigan Agricultural College, U.S.A. (*Michigan Agricult. Coll. Tech. Bull.* No. 28, Oct., 1916).

These samples were obtained by packing the soil firmly into an iron cylinder, screwing on a tightly-closing lid, and pumping kerosene in on top. The kerosene displaced the soil solution, which was collected through a small pipe at the bottom. Morgan states his results on a different scale and system, but for purposes of comparison I have calculated them to the basis used by me.

Results of analyses of Red Mallee root-water and of soil-solution in parts per 100,000 :—

| | Root-water | Solid solution (America). |
|---|---|---|
| Potash ($K_2O$) .. .. .. .. .. | 4·25 | 5·66 |
| Soda ($Na_2O$) .. .. .. .. .. | 7·03 | — |
| Lime ($CaO$) .. .. .. .. .. | 4·48 | 11·45 |
| Magnesia ($MgO$) .. .. .. .. | 1·44 | 11·97 |
| Chlorine ($Cl$) .. .. .. .. .. | 5·88 | — |
| Sulphuric anhydride ($SO_3$) .. .. | 1·79 | — |
| Phosphoric oxide ($P_2O_5$) .. .. | 0·43 | 0·69 |
| Undetermined and loss.. .. .. | 0·22 | 13·03 |
| | 25·52 | 42·80 |
| Less oxygen equivalent to chlorine | 1·32 | — |
| Total salts .. .. .. .. | 24·20 | |
| Organic matter .. .. .. .. | 42·40 (a) | 32·90 |
| Total solids .. .. .. .. | 66·60 | 75·70 |
| Specific gravity .. .. .. .. | 1·0003 | 1·0007 |

(a) Chiefly tannin.

In the root-water analysis the carbon dioxide present in the ash, being produced during incineration, is extraneous, and has been deducted. The chlorine was determined in the water direct. The sample was insufficient to enable me to investigate the nature of the tannin, of which the organic matter mainly consisted.

Unfortunately, the American report does not take cognisance of soda, chlorine, or sulphuric anhydride. The organic matter in the soil water would probably consist principally of humus. Taking the figures for soil solution

as being representative, it is interesting to note how the plant has selected the substances absorbed. Thus potash and lime are taken up in greater relative proportion than magnesia. This selective action is well known. A striking illustration is furnished by marine plants, which, though bathed in a medium containing enormous relative proportions of soda and magnesia, take up very little of these substances, but select the much less abundant potash. Although land-plants do possess a very decided power of selection, we have evidence that this is to some extent overcome by the osmotic pressure of substances in the soil solution, and a plant may be compelled to take up a larger amount of substances like soda or magnesia than it requires, and which may be decidedly harmful. Such a case is furnished in my own experience by the growth of cane-sugar on soil infiltrated with brackish water, on certain parts of the Clarence River, New South Wales, and on what is known as Tiri land in Fiji—low-lying land subject to inundation with sea-water. In such cases quite excessive amounts of chlorides are found in the juice when the cane is crushed.

Another interesting point which requires bearing in mind in case of further investigation of the water from plants, is that brought out by Prof. W. H. Dixon as to the variation in concentration in different parts of the plant ("Transpiration and Ascent of Sap in Plants," 1914, p. 11). Dixon finds that the concentration of solids is greatest in the sap from the roots, and becomes less in the upper parts of the plant. This was determined by the electrical conductivity and freezing-point methods in samples of sap obtained by centrifuging pieces of the roots and stems. The figures obtained by both methods are proportional to the amount of dissolved substance present, and are in close agreement. It was found in the case, for instance, of *Acer pseudoplatanus*, that the sap in the branches at a height of 30 feet had only two-thirds the amount of dissolved substances as that in the roots. In another plant, *Colocasia antiquorum*, a similar distribution was observed, and it is interesting to note that the droplets of liquid transpired from the tips of the leaves consisted not of sap but of practically pure water.

These results, as regards the greater concentration of the sap in the roots, are certainly contrary to what I would have expected, but Prof. Dixon's experiments are most lucidly described, bear evidence of careful execution, and seem to me quite convincing. The Rev. W. B. Clarke (*loc. cit.*), without giving his authority, states his belief that it had been ascertained that the specific gravity of the sap is least in the roots. This would be a most interesting subject for further observation. It will be noticed that in the Red Mallee water the proportions of soda and of chlorine are high relative to the other ingredients. In a series of analyses of Mallee soils published many years ago by the Agricultural Chemist of Victoria ("Report Dept. Agriculture, Victoria," 1875), the amounts of soda and chlorine vary within wide limits, the chlorine in one case rising as high as 0·20 per cent of the soil. This corresponds to about 0·33 per cent of sodium chloride, which is a high percentage for a soil, and is quite sufficient to account for the large proportion of soda and chlorine in the Mallee root-water.

*Not all* samples of sap obtained in the manner of the Mallee root-water are so dilute; Smith (*Proc. Roy. Soc. N.S. Wales*, 1896, p. 194), for instance, found enormously greater amounts of both mineral and organic solids in the sap from the timber of *Grevillea robusta*, while the juices of such plants as the sugar-cane and sugar-maple carry large percentages of sugar, though not of mineral constituents; it must, however, be remembered that in the case of these latter plants the sweet sap is contained in special cells or vessels, and is not the ordinary circulating sap, but apparently functions as a food reserve. In the specimen of these roots exhibited by Mr. Fletcher the cut ends showed a remarkable assemblage of open vascular tubes, reminding one strongly of a section of cane. From consideration of the circumstances I am inclined to think that the Mallee root-water may be a reserve sup for the use of the plant during droughty conditions sto in special vessels.—*Proceedings of the Linnean Society New South Wales*, 1919, xliv., Part 2, June 25.

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## A SIMPLE DISTILLATION APPARATUS FOR SEPARATION OF WATER.

By GEO. W. WALKER.

In many laboratories where routine work is carried o is necessary to re-distil certain solvents for further For this purpose a distillation flask and condenser are aside.

The solvents in many cases contain water—for exam benzene and chloroform,—and on re-distillation this w necessitates the regular exchange of receivers, and, m over, requires the constant attention of the operator, un a revolving receiver be used.

The accompanying sketch (p. 223) illustrate simple device for the distillation of such solvents as n tioned above, and involves no additional expense :—

The apparatus is the same as is used for an ordi distillation, only the distillation flask has two lea tubes, both of which are connected by means of rul tubing—one to the condenser B and the other to flask D.

The liquid in the residue bottle F is blown into funnel H, from whence it is allowed to flow into the tillation flask according to the rate of distillation. clipped and the distillation proceeded with. The w passes down the lower leading tube and is condense the flask D. When all the water has been driven off, clip L is closed and the distillation proceeded with in usual manner.

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## NUTRITION AND PHYSICAL EFFICIENCY

By E. V. McCOLLUM, Ph.D.
Professor of Chemical Hygiene, School of Hygiene and Publi Health, Johns Hopkins University, Baltimore, Md.

(Contined from p. 214).

This leads us to a consideration of the kinds of d which do succeed in the nutrition of animals. In a extensive inquiry, covering twelve years, and based *nearly four thousand feeding experiments*, we have ceeded in nourishing animals in an approximately nor fashion with but three types of diets.

It is possible to so select carnivorous foods as to sec a fairly satisfactory diet entirely derived from ani tissues. Young animals cannot grow or long remai health when restricted to muscle tissue as their sole fo When blood, liver, kidney, and other glandular tissues selected, together with a certain amount of bone substa the food supply is sufficiently good to lead to nor *development. Muscle tissue must be liberally sup*mented with blood or glandular organs and bone to m possible success with the strictly carnivorous diet. carnivorous diet has been used by man occasionally, Eskimo and some American Indians being examples.

It has been found possible to supplement the seed, tu root, and muscle meat type of diet with liberal amount the leafy vegetables and secure a fairly satisfactory d This requires a liberal supplementing with leaf in orde make good the deficiencies of the remainder of the d This type of diet is common among the Orientals.

The third type of diet which succeeds is that deri

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* Presented at a joint meeting of the Section of Physica Chemistry and the Philadelphia Section, American Chemical Soc From the *Journal of the Franklin Institute*, April, 1920.

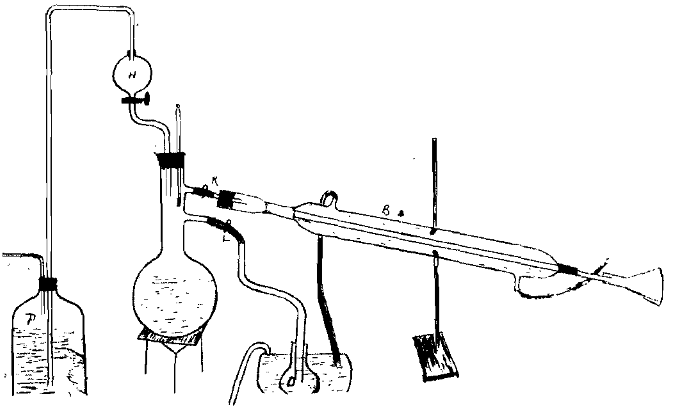
; cereals, legume seeds, tubers, fleshy roots, with or out meats, supplemented with liberal amounts of milk. is so constituted as to make good all the deficiencies ıs classes of foods just enumerated.

Is so important to appreciate the special qualities of eafy vegetables and milk that I have been accustomed esignate these as the *protective foods*. They are prove foods because they are especially rich in just those ients and complexes in which the storage tissues of ts and muscle tissue are poor.

'e will now turn our attention to the application of the ) discovered through animal experimentation to human ilems. On careful consideration it strikes one that more advanced peoples of the world are those who on the vegetable and meat diet supplemented with and its products. The second class in respect to incement and aggressiveness are those which eat *ally of the leafy vegetables. All strictly carnivorous* live in climates which preclude the development of high degree of civilisation. They have nothing to

physical and mental. This assertion he bases upon careful observations on the amount of work of several kinds which workers accomplish in climates varying from that of Connecticut to Florida. Temperature he *finds to be* the important factor in determining the aggressiveness and ambition of the individual. The farther south the more uniformly warm it is, and the more the climate departs from the typical cyclonic stormy type so characteristic of the northern states of England.

Huntington further correlates the character of the climate of Europe, Asia, Africa, and North and South America, with the state of advancement of their peoples, and finds a remarkable relationship between them. Monotony of climate over long intervals is said to be detrimental to achievement. He eliminates race as an important factor in determining the problem by pointing among other illustrations to the condition of the white people of the Bahamas, *who are the descendants of virile Southern* settlers, as contrasted with that of other loyalists who at the time of the revolution emigrated to Canada. The



: for further than food, shelter, and clothing, and do accumulate much property.

'here can be no doubt that there are carnivorous nals, such as the lion, tiger, and jaguar, which live in hottest parts of the world, yet represent some of the examples of physical development in the animal ;dom. Neither the heat, monotony of high tempera- , humidity, or aridity can be said to interfere with sical development.

'he tiger thrives in the wet estuaries of Bengal, and jaguar *in the hot and sultry forests of Brasil. The* is equally vigorous on a margin of the desert. We find no evidence that climate is a factor of any apprele importance in the development of lower animals so as physical well-being is concerned.

Huntington has made a very plausible case for climate he most important factor in determining the efficiency nan in the different regions of the world. He points that the changes in the condition of the weather so acteristic of the northern parts of the United States lower Canada in the western hemisphere, and of gland, northern France, Holland, southern Germany, , are the ideal conditions for stimulating effort both

former have degenerated into "poor whites," who are too proud to work at *menial labour in competition with the* negro, and too shiftless to compete with him successfully. The latter are among the most prosperous and progressive citizens of one of the finest examples of a commonwealth in the world.

Huntington sees no great hope for the future of civilisation in Asia, Africa, or South America, because the white man, who is regarded as superior to the other races, degenerates in their enervating climates. The view is *held that when the white man migrates to climates less* stimulating than those of his original home, he appears to lose both physical and mental energy. If it is true that under such influences man becomes careless of sanitation and of food, and thus secondarily becomes susceptible to diseases, then indeed there is little reason to hope that the dream of the hygienist can be realised that the tropics can ultimately be made the abode of a cultured population.

Plausible as is the correlation between climate and civilisation which Huntington has constructed, it seems to me that another interpretation can be placed on all the data which he presents, which in the light of what we now know about the effects of diet on health will come

nearer the truth. In order to appreciate the importance of diet on the welfare of nations we should consider for a moment the effects of certain types of faulty nutrition on the life history of experimental animals.

When a full-grown animal such as a rat is placed on a diet of seed, tubers, fleshy roots, and muscle meats, it begins to hurry through its span of life, developing the characteristics of old age at a rate double or more the rate observed in a well-nourished animal. It does not succeed well with the nutrition of its offspring, and dies at a fairly early age. The young, if restricted to the diet of the parents, are never their equal physically, have poor success with their young, *live much less long* than the species is capable of, and are subject to infections and abnormalities in a degree unknown to their ancestors. With each succeeding generation weaklings predominate, and the strain dies out within a few generations.

If we apply to the natives of the Bahamas the test of nutrition we find that the diet is of such a character as to account for degeneration in considerable degree within the period since the islands were settled by loyal Tories who were not willing to live under the Stars and Stripes. During this period they have depended for their food supply largely on citrus fruits, pomegranates, pineapples, bananas, melons, yams, potatoes, guinea corn, and peas. This it will be noted is a list consisting of fruits and other storage tissues of plants. It has been supplemented with a certain amount of animal foods, principally fish, although some muscle meats from mammals have been eaten. This type of diet, it will be remembered, is unsatisfactory for the nutrition of an animal over many generations, and leads to deterioration in the stock. This is the condition found in the Bahamas.

On the other hand, the people of Canada have lived essentially on the same type of diet as that employed in the northern United States. It includes all the products of field and garden with which we are familiar, together with meats in liberal amounts and dairy products in moderate quantities. The latter is the kind of diet which supports the civilisation of England, and also the most progressive European countries as well as that of the northern United States, and all other parts of the world which have been peopled by colonisation from European stock, wherever the climate will permit.

Another example of the failure of health of European people largely as the result of restricted diet improperly selected is found in Newfoundland and Labrador. There occurs in both these districts the deficiency disease beri-beri, which is caused by lack of a sufficient amount of the dietary essential water-soluble B. The disease is the same that is seen so frequently among the poor labouring classes of the Orient who subsist largely on a diet of polished rice and fish with a few vegetables. The diet in Newfoundland consists, according to Dr. Little, of bread made from bolted wheat flour, tea, fish and salt meats, and raisins. A similar food supply is all that is available in Labrador.

There seems good reason to believe that a second deficiency disease actually occurs among the people of both these regions as the result of their restricted and faulty diet. I refer to a condition popularly called night blindness, which is common, especially among men who are out at sea for a considerable period and are subjected to a fare of poorer quality than that obtainable at home. I cannot affirm that it is demonstrated that this is incipient xerophthalmia due to a lack of the unknown dietary complex found most abundantly in butter fat and a few other fats, but there is good reason to believe that it is. Night blindness occurs among men in lumber camps in Canada and elsewhere, and the popular local remedy is to feed the patient with milk or cheese. Prompt recovery is said to follow this modification of the diet. In these camps the food supply is frequently limited to bread, salt or canned meats, and peas or beans for considerable periods. This again is a seed and meat diet, and has been found to be unsatisfactory for animals and for man. The same condi-

tion appears to be occasionally met with in Japan, a
not uncommon in parts of India. In both of these cou
the popular remedy is the free use of liver as a food
in India it is recommended that a poultice of liv
applied to the eyes as well. It is safe to say that it
consumption of the glandular tissue that results in b
to the eyes of the sufferer. In Japan eel fat and ch
livers enjoy the reputation of being efficacious in th
of xerophthalmia. Night blindness is reported to b
with in Russia somewhat commonly during the latte
of the Lenten fast. During this period the people re
their diet largely to cereals, and fail to secure enou
the dietary factor which is concerned with the dete
tion of the eyes.

According to the views of those who believe that cli
in itself is the chief factor in determining the progre
ness of a people, it will never be possible for a peo
central Asia to develop a high state of civilisatio
seems worth while to examine into the validity of thi
clusion, and in doing so we must make it clear what
ditions we accept as a fundamental basis of civilis
If physical well-being as exemplified in excellent de
ment, together with courage and energy, be the
requisite, we have had in the past and have now
notable examples of it among the central Asian tribe
It is necessary, however, in order that a high deg
civilisation shall be reached, that a relatively high
of mental development, together with both socia
political fixity, shall be attained.

Of fundamental importance for the development
highly organised society and a state of advanced ci
tion is the right kind of religion, since this determin
mental attitude of the individual toward his asso
his neighbours, and his own destiny.

The Mongol hordes of Central Asia in the thirteen
the sixteenth centuries over-ran and conquered m
Western Asia and Europe, as far westward as the bou
of Austria-Hungary. Eastward they over-ran a larg
of China, and to the north they were for generati
thorn in the side of the Russians. These Mongols
played so prominent a part in history, were typical
sentatives of the sour milk drinkers so common amo
pastoral people of all parts of Asia and eastern E
At the present time the natives of north-west Mo
have many cattle, sheep, horses, and camels, and
their sustenance almost entirely from their flock
herds. The Mongols had all the elements necessa
the creation of a high development of civilisation
the mental attitude toward society which would
them to respect the personal and property rights of
They had not the sense of honour and the apprecia
the ethical relations between man and man whi
necessary for the establishment of a stable society
on law and order and governed in the interests
people. Such governments had not at that time
popularity anywhere in the world. The frame of
which makes possible these things can be attaine
through the establishment of the best system of re
Climate had nothing to do with these.

The ancestors of the present Turks were like
pastoral people and were sour milk drinkers. This
tuent of their diet would alone suffice to make it
satisfactory, and to insure, in the absence of cont
or of insect-born diseases, an excellent physical de
ment. Such a development is the essential ba
military ambition and success, and was possessed by
the Mongols and the Turks.

The Arab of to-day is an example of the effects
diet in which sour milk finds a prominent place.
described by all modern writers as singularly hand
tall and lithe, with beautifully moulded limbs. D
hunchbacks, and misshapen persons are seldom s
Arabia. Few races of humanity excel the Arab
physically or morally. The Arab derives his sust
in great measure from his animals and milk. Most
milk is soured, but this forms the most prominen

ent of his diet. In fact, under the name sheneena, 1, yoghourt, keffir, koumiss, matzoon, and dadhi, ed milks have been used from earliest times very nsively over a large part of central Asia, as well as pt, Palestine, Arabia, Turkey, and the Balkan States. erever fermented milks are extensively used as food physical development of the people is unusually good, the length of life exceptionally long in many instances. lmost everyone is familiar with the conclusions of the ous *Russian bacteriologist Metchnikoff*, that the arkab'e number of centenarians among the Bulgarian antry was the result of the ingestion of sour milk. chnikoff believed that the remarkable results of the iar use of their simple diet was due to the lactic acid ucing organism which causes the souring of the milk. beneficial effects he attributed to the production of ic acid by this organ in the intestine, and the inhibition he growth of the harmful putrefractive organisms ch develop there in the residues of protein rich foods. attributed the early ageing of mankind and of animals he absorption of these toxic products.

is of more than ordinary interest that the most lern investigations in the field of nutrition, carried out nethods which far surpass those of the past in scientific iracy, support his observations in a general way as irds the beneficial effects of the diet of the people be erved, but detract from the importance of the organism ch the milk contains. It is the correction of the ciencies of the types of diet which consist mainly of l products, tubers or fleshy roots, and muscle meats, by inclusion of the protective food milk, which accomhes the result of greatly improving health and increasvigour. The bacteria in the milk are of secondary ortance.

(To be continued).

# PROCEEDINGS OF SOCIETIES.

## SOCIETY OF CHEMICAL INDUSTRY.

FERENCE OF ENGINEERING GROUP AT BIRMINGHAM.

e third Conference of the Chemical Engineering Group the Society of Chemical Industry, at Birmingham iversity on Friday, April 23, was most successful. out 140 members and industrial chemists were present. : Chairmen at the sessions were Mr. W. A. S. CALDER ance and Hunt) and Mr. C. A. SMITH (Edwin Danks, bury, Ltd.). A Dinner took place in the early evenat the Grand Hotel.

*Labour Saving Devices in Chemical Works*" was the ject discussed.

t was announced that the Fourth Conference would e place at Newcastle on July 13 and 14, on the asion of the Annual Meeting of the Society of Chemical ustry, and the subject for discussion will be "Filtration." dern types of centrifugal filters, continuous and intertent, under works conditions will be shown.

'he subjects discussed were as follow:—

Modern High-Speed Electric Telpherage and its Applications in Chemical Works." By H. BLYTH, A.I.M.Mech.E., A.M.Inst.C.E., Chief Engineer, Telpherage Dept., Strachan and Henshaw, Ltd., Bristol.

Pneumatic Conveying of Coal and Similar Substances." By H. J. H. KING, M. I. Mech. E., Managing Director of H. J. H. King & Co., Ltd., Nailsworth, Gloucester.

Some Notes on Portable Conveyors and Transporting Trucks." By Capt. C. J. GOODWIN, A.C.G.I., B.Sc. (Eng.), A.M.Inst.C.E., Consulting Chemical Engineer.

"Pneumatic Conveying of Granular Substances, including Chemicals." By GORDON S. LAYTON, of Messrs. Robt. Boby, Ltd., Bury St. Edmonds.

"The Importance of the Mechanical Handling of Material and its Relation to Production Costs." By H. VARNDELL, of Messrs. W. & C. Pantin, Ltd., 147, Upper Thames Street, London, E.C 4.

"Automatic Filling Machines for Liquids." By H. F. BROADHURST, of Alison Broadhurst Machine Co., Ltd., Finsbury Square, London, E.C.

"Developments of Automatic Weighing Machinery and its Application to the Chemical Industry," by S. H. JOHNSON, of W. and T. Avery, Ltd., Birmingham

Dealing with telpherage, Mr. BLYTH put machinery depreciation down at 12½ per cent, and structural work at 2½ per cent. Telpherage was being increasingly used, he said, in dealing with coke and coal at gas and electricity works.

Regarding pneumatic coal conveying as seen at Messrs. Boots' (Nottingham), it was stated that there was a certain amount of wear at the bends, but repair work was neither difficult nor expensive. If coal were damp extra vacuum was allowed.

Answering Mr. Tungay, Mr. KING stated that material with a higher specific gravity than coal could be handled successfully. Crushed wood, wet and dry, and bark from tanneries could be dealt with.

Mr. A. E. MALPAS said that in a pneumatic installation at Liverpool for dealing with boiler ashes the wear at the bends was considerable. By pre-heating of the air, trouble arising in wet weather from condensation in the *pipes of installations dealing with the transmission of* documents was avoided.

Mr. E. G. PHILLIPS, who is associated with the plant, said unloading of coal by it was absolutely dustless. The breakage of coal was small, and with an easy bend it was not broken.

Mr. KING said coal could be distributed by this means quite easily at various points in a chemical yard. Seashore side could be conveyed quite easily, but with 10 per cent of moisture there was liability to stick to the pipes.

On the subject of portable conveyors and transporting trucks, Capt. GOODWIN said the latter was eminently suited for the handling of carboys. If there was any likelihood of spilling acid, &c., a lead covering could be used.

Mr. BLYTH thought portable conveyors could be usefully used in conjunction with other means of handling, such as the Telpher, and particularly in relation to lifting coal from barges. It did not pay sometimes to put in a Telpher line.

At the evening session, Mr. SMITH (chairman), addressed the Conference, speaking of the importance of such meetings to create the right kind of atmosphere. It was the only way to get rid of national indifference which chemical science was up against.

As to the *pneumatic conveying of granular substances*, discussion chiefly centred round the question of filtration of dust, methods such as electrostatic deposition, a combined system of cyclones and filter-bags, and the use of the hydro-turbine being suggested for vacuum purposes.

*MR. LAYTON said chemical dust was not finer than grain* dust, and the results were excellent. The wear at the bends was not difficult, and if coal were handled special provision for protecting the pipe could be taken. With a square section, plates could be bolted on, so that the renewal meant merely an extra plate. No difficulty was experienced in conveying grain with 20 per cent of moisture or cement.

Dr. G. S. WALPOLE said such conveyors were common in Germany, They were most successful, and he believed their practice would become universal.

The thanks of the Conference were extended to Mr. F. R. O'Shaughnessy, hon. secretary of the Birmingham and Midland Section of the Society of Chemical Industry, for

having made the local arrangements. On Saturday the members visited the works of the B.S.A. Company at Small Heath, Birmingham.

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The subject of "*Catalysis*" was further considered at a recent meeting of the Birmingham and Midland Section of the Society of Chemical Industry, with special relation to its application to the following industrial operations:—Vulcanisation, Oxidation of Oils, Oil Hardening, and Oxidation of Cellulose.

Mr. L. P. Wilson, F.I.C. (Coventry), presided over a representative assembly of industrial chemists.

*Oil Hardening.*—Examples of catalysis applied to oil hardening were given by Mr. A. W. Knapp, B.Sc., F.I.C. (Cadbury's, Ltd.), who spoke of experiments made by him nine years ago. To-day there were 25 factories in Europe and the United States working at oil hardening, but he doubted if ten years ago there were more than 25 workers engaged in research work. The remarkable advance made was an example of laboratory research leading to a great industry. It might be called "The Dream of the Soap-makers Come True." The soap-maker had always been able to obtain cheap liquid oils, solid fats having been more costly, and it had long been the soap-maker's desire to convert oils into fats. From the theoretical standpoint it looked simple to convert the liquid oleic acid into the solid stearic acid (the former being the candle-maker's by-product); all that it was necessary to do was to persuade a molecule of the unsaturated oleic acid to take up a molecule of hydrogen. Methods were suggested, but they were cumbrous and unsatisfactory. The work of Sabatier and Senderens showed the possibility of using nickel as a catalyst for this reaction, and for the last fifteen years the work had consisted of finding a method of obtaining a catalyst in its most active form, and working out the most suitable apparatus for effective contact.

Mr. Knapp said he had made a few experiments with platinum and palladium, founded on the researches of Paal and Roth (1911). They found that if a solution of colloidal platinum or palladium were made into an emulsion with fat with the help of gum-arabic, and hydrogen passed through, that the hydrogen was absorbed and the fatty matter hardened. Owing to its unsuitability for commercial application a great improvement was effected when they suggested the precipitation of the metal on some inert substance, and the placing of this direct in the fat. He used solutions of platinum dichloride and palladium dichloride, and he tried precipitating those metals or their hydrates on light magnesia. They were poor catalysts, and he abandoned them for precipitating on magnesium itself. He found that if platinum or palladium asbestos were put in a dilute solution of permanganate that it could be readily reduced by bubbling hydrogen through it, and it was possible to get some idea of the time required in the reduction of the colour as to the activity of the asbestos. The ordinary nickel catalyst, however, appeared incapable of accelerating this reduction, and this was also true of the magnesia catalysts. In the preparation of the palladium catalyst he used 1000 parts of water, 100 parts of magnesium, and 1 part of palladium as palladium dichloride. When powdered magnesium was mixed with water no obvious action occurred, but on the addition of the palladium dichloride a brisk evolution of hydrogen began, the temperature rose until the water boiled, and a considerable quantity of oxide of magnesia was formed. The hydrogen formed was frequently spontaneously ignited by the particles of palladiumised magnesium on the surface of the bubble. It was evident that this method of preparation of the catalyst on a large scale might present some danger, and he found it well to keep the water cool and to wash with alcohol and then with ether.

As to oils it was important that they should be clean. ...oils or freshly pressed oils could sometimes be improved by heating above the temperature required for the catalyst, allowing to cool, and then filtering. The effect of heating was apparently to coagulate some of the colloidal matter which otherwise would be deposited on the catalyst. Complaints had been made that the soaps prepared from hardened oils, whilst hard and economical, did not lather freely. When one considered that the soap produced would be sodium stearate that was easily understood, but it was readily got over in practice by limiting the proportion of hardened oil used in the preparation of any soap.

Mr. Knapp commented on the fact that large quantities of hardened fats were used for edible purposes, and he thought it was time that some statement was made as to the quantity that the public was absorbing, because although a good deal of work had been done, he thought that the wholesomeness was still open to question. Hardened oils kept, however, remarkably well, and kept free from rancidity. He had been surprised that a cocoa-butter substitute consisting of hardened oil had been offered for sale, considering that the price of cocoa butter was 2s. 11d. per lb. wholesale.

*The Oxidation of Cellulose.*—Mr. L. P. Wilson's contribution was on "Catalytic Action in the Oxidation of Cellulose." He pointed out that in the manufacture of artificial cellulose fibres from cellulose, the most commonly employed method was the viscose process, in which cellulose xanthate was produced and dissolved in dilute alkali to form a solution. This solution was projected through fine apertures into a coagulating medium and so was formed into filaments. The first stage in the production of a solution, whether the starting material be wood or cotton, was the formation of alkali cellulose by immersion in a strong solution of caustic soda of over 15 per cent strength. That caused a partial gelatinisation of the fibres, and the formation of a definite chemical compound which after a process of oxidation and subsequent reaction with carbon bisulphide formed sodium cellulose xanthate, a brownish plastic solid which was soluble in water, forming a liquid of high viscosity. Whether or not the cellulose xanthate would form a solution which could be used for the production of threads depended largely on the exact amount of oxidising action to which the alkali cellulose was submitted; that was, in any case, very small, but it caused an alteration in the molecular arrangement of the cellulose, and determined whether the xanthate when mixed with water was a stiff gel or a liquid less viscous than glycerin; the chemical difference between those two conditions could not be stated, but the physical differences were most marked. This oxidation has been generally effected by exposure to the atmosphere, and, at the ordinary temperature (say 20° C.) the process might take four days. If oxygen were introduced by other means, such as by treatment with peroxides or hypochlorite, the time might be reduced in proportion to the activity of the oxidising agent employed. One per cent of sodium peroxide added to the caustic soda solution used to produce the alkali cellulose, resulted in a sufficient oxidation taking place during a steeping period of about five hours. Whichever method of oxidation was employed—either exposing to air after the formation of alkali cellulose or oxidising while still in the caustic soda solution—the process could be greatly accelerated by the use of suitable catalysts. These catalysts were generally oxides or hydrates of metals, which exist in two states of oxidation; for example: iron, nickel, cobalt, cerium, vanadium, and manganese. The catalyst was applied either by first impregnating the cellulose with a salt of the nickel, or by suspending the hydrated oxide in a fine state of division in the caustic soda solution. Lead, although not an oxidising catalyst when used by itself, acted as a catalytic accelerator in conjunction with manganese.

*Catalysis and Oxidation of Oils.*—Dr. R. S. Morrell, M.A. (Wolverhampton), contributed a paper on "Catalysis applied to the Oxidation of Oils." He pointed to the complex constitution of oils and laid stress on the great

iety of changes that take place during oxidation. In oxidation of linseed-oil he favoured the view of polyrisation accompanying the formation of peroxides. He l stress also on the necessity of considering the interial tensions of drying oil films to air, water, and nitrogen. . Morrell gave results of measurements of surface tension metallic drying oils, showing that lead differed markedly m cobalt and manganese in superficial properties. the application of Gibbs' rule differences between the ee metals, as driers, could be explained which were accountable under Engler's intermediate compound ory, or by explanations such as advanced by Kochs. e urged that more attention must be paid to the study the catalytic oxidation of oils from the standpoint of er-facial forces whereby connection may be established tween these and the chemical changes which were known occur during the drying and setting of oils.

## NOTICES OF BOOKS.

*undation Course in Chemistry.* Second Edition. By J. W. DODGSON, B.Sc. (Lond.), A.I.C., and J. A. MURRAY, B.Sc. (Edin.). 1920. London: Hodder and Stoughton. Pp. xii + 241.

UDENTS in agriculture, dairying, and allied subjects ll be interested to learn that Messrs. Dodgson and urray have issued a second edition of their book, which as first given to the public in 1912.

The authors have entirely revised the first edition and ought it up to date. A new chapter on Physical emistry is added. In this section the student is introiced to some of the simpler problems, such as Diffusion Gases, Liquefaction of Gases, Osmotic Pressure, &c.

The arrangement adopted is novel. The idea which as influenced the authors in setting out the book is to ke advantage of that which the student already knows garding the common things in life, the things with which eryone is more or less familiar, to formulate this knowdge, extend it, and incorporate the whole in a homoneous system.

In this way the book is divided into nineteen chapters, ith an appendix containing a table of International tomic Weights, Tables of Weights and Measures, and ree pages of examples for calculation with answers.

The phraseology used should be understood by all. A easing thing about the book is the total absence of emical formulæ until their significance has been carelly explained, which is done in Chapter VI., entitled General Principles."

## NOTES.

THE Secretary of the Department of Scientific and dustrial Research announces that a licence, under ection 20 of the Companies' (Consolidation) Act, 1908, as been issued by the Board of Trade to The Scottish hale Oil Scientific and Industrial Research Association, hich has been approved by the Department as complying ith the conditions laid down in the Government Scheme r the encouragement of industrial research. The ssociation may be approached through W. Fraser, Esq., .B.E., Scottish Oils Ltd., 135, Buchanan Street Glasgow.

AT the Annual General Meeting of the Manchester iterary and Philosophical Society the following Officers ere elected for the session 1920 21:—President—Sir lenry A. Miers, M.A., D.Sc., F.R.S. Vice-Presidents—Dr. Francis Jones, M.Sc., F.R.S.E.; Mr. R. L. Taylor, .C.S., F.I.C.; Mr. William Thomson, F.R.S.E., F.I.C.; nd Mr. R. H. Clayton, B.Sc. Hon. Secs.—Dr. H. F. owards, F.I.C., and Professor C. A. Edwards, D.Sc. lon. Treasurer—Mr. W. Henry Todd. Hon. Librarian—Dr. G. L. Barnes, M.A. Hon. Curator—Prof. W. V. Haldane Gee, B.Sc., M.Sc.Tech.

## MEETINGS FOR THE WEEK.

*Monday, May 10.*

Royal Society of Arts, 8. (Cantor Lectures). "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758—1837," by A. T. Bolton.
Biochemical Society, 5.30.
Royal Geographical Society, 5.
Institution of Mechanical Engineers, 8.

*Tuesday, May 11.*

Royal Institution, 3. "British Ethnology—The Invaders of England," by Prof. Arthur Keith.
Royal Photographic Society, 7.

*Wednesday, May 12.*

Royal Society of Arts, 4.30. "Rolls of Honour," by Grailly Hewitt.

*Thursday, May 13.*

Royal Society, 4.30. "Demonstration of the Apparent 'Growth' of Plants (and of Inanimate Materials) and of their Apparent 'Contractility,'" by Dr. A. D. Waller "On the 'Renal Portal' System (Renal Venous Mesh work) and Kidney Excretion in Vertebrata," by W. N F. Woodland.
Royal Institution, 3. "Welsh and Irish Folk Song,' by A P. Graves.
Institution of Electrical Engineers, 6.
Optical Society, 7.30.

*Friday, May 14.*

Royal Institution, 9. "Sidelights in the Evolution of Man,' by Prof. Karl Pearson.
Physical Society, 5. "Experiments on the Thermioni Properties of Hot Filaments," by Dr. F. Lloyd Hop wood. "A Modified Thory of Crookes Radiometer, by G. D. West. "Magnetic Properties of Silicon-Iro (Stalloy) in Alternating Fields of Low Value," by A Campbell. "On Tracing Rays through an Optic System," by T. Smith.
Iron and Steel Institute, 3. (At University, Sheffield).
Institution of Electrical Engineers, 6.

*Saturday, May 15.*

Royal Institution, 3. "A Philosophical Synthesis as pro posed by Auguste Comte," by Frederic Harrison.

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3063, December 20th, 1918.
3064, January 3rd, 1919.
3066, January 17th, 1919.
3068, January 31st, 1919.
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## NOTICES.

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**SUBSCRIPTIONS**, £1 per annum, payable in advance, sho[uld be] addressed to the MANAGER.

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CHEMICAL NEWS
VOL. CXX., No. 3135. 325/1875

METHYL STANNONIC ACID: OF ITS SALTS AND DERIVATIVES.

By J. G. F. DRUCE, B.Sc., A.I.C.

·h (*Zeit Anorg. Chem.*, 1902, xxx., 289) advanced that potassium hydrogen stannite has the

$$H-Sn{<}^{=O}_{OK}.$$

the case it is analogous to potassium formate,

tin occurs in the same group as carbon in the Classification of the Elements, it seemed of in-ascertain whether other acids and salts containing ent tin analogous to the aliphatic organic acids isolated. The analogue of acetic acid would formula $CH_3.SnOOH$, that of propionic acid $C_2H_5.SnOOH$, &c.

per on mono-methyl tin compounds Pfeiffer and (*Ber.*, 1903, xxxvi., 1054) incidentally describe l of preparing methyl stannonic acid. A simpler as been devised for preparing the acid in a pure

obtained as an amorphous solid and has little in with acetic acid. It dissolves in caustic alkalis, the methyl stannonates. Solutions of the alkali ve precipitates with such solutions as those of ulphate, ferrous sulphate, nickel sulphate, zinc , &c. The precipitates were found to be metallic annonates.

carefully concentrated the alkaline solutions l crystalline salts, which would be redissolved

l stannonic acid also dissolved in solutions of gen hydracids, forming tri-halogen derivatives. hydrochloric acid methyl tin trichloride resulted g to the equation :—

$$CH_3SnOOH+3HCl = CH_3SnCl_3+2H_2O.$$

c alkalis reacted with these halogen compounds, ting the salt of methyl stannonic acid.

a few preliminary experiments it is found that in trichloride forms double salts with various amine lorides. These salts may be regarded as stanni-, or the salts of an alkyl substituted chlorostannic $_2RSnCl_5$. The salts have the general formula $nCl_5$. Aniline, methylaniline, and pyridine annichlorides have been prepared.

*Preparation of Methylstannonic Acid.*

ture of 20 grms. of stannous chloride in 50 cc. of as added with stirring to 100 cc. of a 20 per cent of potassium hydrate. After standing for an liquid was filtered. To this solution of potas-nnite 100 cc. of alcohol were added together with of methyl iodide. The flask containing the mix-shaken at frequent intervals and allowed to stand e days. The reaction that occurred may be d :—

$$K_2SnO_2+CH_3I = CH_3.SnOOK+KI.$$

ltered solution was transferred to an evaporating d the alcohol was slowly removed by warming on bath kept at about 40° C. Hydrochloric acid was then carefully added until the solution was acid to litmus and the white gelatinous precipitate began to redissolve. The precipitate was collected on a Buchner funnel, drained, and washed with cold water a dozen times until the wash-water no longer contained any chlorides.

The residue was dried in a desiccator over sulphuric acid. Yield, 13·5 grms.

In another preparation an alcoholic solution of methyl bromide in approximately equivalent amount was employed in place of the methyl iodide.

On analysis 0·4293 grm. gave 0·3864 grm. $SnO_2$; per cent Sn = 70·9.

$CH_3SnOOH$ requires Sn = 71·2 per cent.

*Properties of the Acid.*

The acid was obtained as a white amorphous infusible solid which decomposed on heating to redness, leaving white stannic oxide. When mixed with ammonium nitrate and gently heated it decomposed very rapidly, giving off carbon dioxide and water vapour, and stannic oxide remained. When heated in absence of air it gave off methane and left a greyish residue which was partly soluble in hot dilute hydrochloric acid. This decomposition may be represented :—

$$CH_3SnOOH = CH_4+SnO_2.$$

The reaction probably does not follow this equation quantitatively.

Methyl stannonic acid dissolved very readily in cold solutions of sodium, potassium, and ammonium hydrates, and in lime-water. It was insoluble in solutions of the alkali carbonates and in ordinary organic solvents (alcohol, ether, benzene, toluene, chloroform, acetone, aniline, and pyridine were tried). It dissolved in concentrated and dilute mineral acids, acetic acid, and tartaric acid.

*The Halogen Derivatives.*

*Methyl Tin Tri-iodide*, $CH_3SnI_3$.—When treated with hydriodic acid methyl stannonic acid dissolved on warming, and then oily drops separated and fell to the bottom. They solidified on cooling. The substance was recrystallised from alcohol as a pale yellow solid.

On analysis 0·1947 grm. gave 0·2627 grm. AgI; I = 72·9 per cent.

$CH_3SnI_3$ requires I = 74·01 per cent.

When warmed with alkalis the substance underwent hydrolysis, re-generating the alkali salt of methylstannonic acid. Methyl tin tri-iodide had a peculiar pungent odour recalling that of garlic. It melted at 82°.

*Methyl Tin Tribromide*, $CH_3SnBr_3$.—This substance was prepared by acting upon methylstannonic acid with a strong aqueous solution of hydrobromic acid, and crystallised in the form of shiny needles which melted at 52°. When warmed with caustic alkalis the crystals decomposed, regenerating alkali methylstannonate and haloid, according to the equation :—

$$CH_3SnBr_3+4NaOH = CH_3.SnOONa+3NaBr+2H_2O.$$

On analysis 0·2104 grm. gave 0·3045 grm. AgBr; Br = 61·6 per cent.

$CH_3SnBr_3$ requires Br = 62·0 per cent

*Methyl Tin Trichloride*, $CH_3SnCl_3$.—This compound was similarly prepared by warming the stannonic acid with concentrated hydrochloric acid. A clear solution resulted, from which colourless deliquescent crystals were deposited. These melted at about 40°, and were hydrolysed like those of the bromide and iodide by warming with alkalis

On analysis 0·3780 grm. gave 0·6903 grm. AgCl; Cl = 44·1 per cent.

$CH_3SnCl_3$ requires Cl = 44·33 per cent.

*Aniline Methylstannichloride*, $(C_6H_5NH_2)_2H_2(CH_3)SnCl_5$.—This salt was obtained by dissolving 1·2 grms. of methyl tin trichloride and 1·3 grms. of aniline hydrochloride in 20 cc. of hydrochloric acid (1 volume of acid diluted with 2 volumes of water) by heating. After concentrating on a water-bath and cooling, the solution deposited short white needle prisms, which were filtered off, drained, and dried. They melted at 214°, and dissolved in cold water to form a clear solution, which was acid to litmus and remained unaltered on boiling. With hydrogen sulphide the solution gave a white precipitate insoluble in dilute nitric acid. The solution gave no precipitate with mercuric chloride.

The salt was also prepared from methyl stannonic acid (1·6 grms.) and aniline hydrochloride (2·5 grms.), by dissolving these together in 30 cc. of dilute hydrochloric acid.

On analysis 0·3755 grm. gave 0·1104 grm. $SnO_2$; Sn = 23·15 per cent.

0·3755 grm. gave 0·5394 grm. AgCl; Cl = 35·52 per cent.

$(C_6H_5NH_2)_2H_2(CH_3)SnCl_5$ requires Sn = 23·78 and Cl = 35·56 per cent.

*Methyl Aniline Methylstannichloride*,—

$$(CH_3NHC_6H_5)_2H_2(CH_3)SnCl_5.$$

—This compound was prepared by dissolving 2 grms. of methyl aniline and 1·6 grms. of methylstannonic acid in 40 cc. of dilute hydrochloric acid and concentrating the solution on a water-bath until it commenced to crystallise.

Methyl aniline methylstannichloride separated as small white granules, which melted at 194° and dissolved in water, giving a clear solution which reacted acid to indicators.

On analysis 0·5596 grm. gave 0·1566 grm. $SnO_2$; Sn = 22·03 per cent.

0·5596 grm. gave 0·7613 grm. AgCl; Cl = 33·64 per cent.

$(CH_3NHC_6H_5)_2H_2(CH_3)SnCl_5$ requires Sn = 22·51 and Cl = 33·67 per cent.

*Pyridine Methylstannichloride*, $(C_5H_5N)_2H_2(CH_3)SnCl_5$.—Methylstannonic acid (1·6 grms.) and pyridine (1·6 grms.) were dissolved together in 30 cc. of dilute hydrochloric acid by warming. On standing after slight concentration on a water-bath, the solution deposited pale yellow shiny plates which melted at 300°. They dissolved in water, giving a clear solution.

On analysis 0·2746 grm. gave 0·0916 grm. $SnO_2$; Sn = 26·3 per cent.

0·2746 grm. gave 0·4318 grm. AgCl; Cl = 38·17 per cent.

$(C_5H_5N)_2H_2(CH_3)SnCl_5$ requires Sn = 25·12 and Cl = 37·67 per cent.

These three double salts resembled the aromatic amine stannichlorides (Chemical News, 1919, cxviii., 87). All dissolved in water, dilute mineral acids, methyl and ethyl alcohols, but were insoluble in benzene, toluene, and chloroform.

Pfeiffer's method (*loc. cit.*) of preparing methyl stannonic acid was not followed, since the passing of carbon dioxide into an alkaline solution of the acid caused by the separation of a compound he termed methyl stannoyl potassium carbonate. Heating the alkaline solution was avoided in case it caused any decomposition, whilst Pfeiffer did this in order to decompose the compound. The substance was obtained as white crystalline platelets which dissolved in water, giving an alkaline solution. Dilute hydrochloric acid reacted with it, giving off carbon dioxide. It was insoluble in all the organic solvents tried.

## THE SYSTEMATIC DETECTION OF AC

By L. J. CURTMAN, D. A. BROGGI, and V. FO

*Introduction.*—The object of this investigatior fold; first, to determine the sensitiveness of c for acetates under definitely specified condition to provide a systematic and reliable proced detection of acetates in solutions containing acids. The three tests for acetates most comr are:—(1) The liberation of acetic acid by sulpl (2) the formation of a red colour when ferric added to an acetate in neutral solution; and (3 acetic test. This test has been shown to be too to be of service in qualitative analysis (Cu Harris, *Journ. Am. Chem. Soc.*, 1917, xxxix., 1

*Test with Sulphuric Acid.*

*Determination of the Sensitiveness of the* determine the sensitiveness of the test for acet depends upon the liberation of the free acid (1 : 1) (see Note) a definite volume of a standa of $NaC_2H_3O_2$ was treated in a small evapo with 2 cc. of $H_2SO_4$ (1 : 1), heated to boilin odour immediately noted. The results obtained in Table I.

(Note.—The use of concentrated sulphur objectionable for the following reasons:—O $SO_3$ fumes are given off which mask the odou acid. When the solid acetate is heated with co $H_2SO_4$, the acetic acid is given off in the anhy which has a penetrating odour and is not recognised as when diluted with water vapour ment, furthermore, has shown that when the co $H_2SO_4$ is employed the odour of acetic acid do as long as when the diluted acid is used; a quence the detection of small quantities of made more certain with the use of diluted $H_2SC$

Table I.

| No. | Mgrms. of $C_2H_3O_2$ (vol. 1 cc.). | Resu. |
|---|---|---|
| 1 | 1 | Very faint |
| 2 | 2 | Faint odo |
| 3—7 | 3—7 | Fairly str |
| 8—9 | 8—9 | Strong od |
| 10 | 10 | Very stron |

The odour does not last long. A control w each case with 0·5 mgrm. of acetate (vol. negative result was obtained.

*Determination of the Interference of Nit* determine the extent to which nitrates interfer series of experiments was conducted. The proc the same as that followed in the determinati sensitiveness of the test, except that 500 mgrm were present in each case.

Table II.

| No. | Mgrms. of $NO_3$ (vol. 1 cc.). | Mgrms. of $C_2H_3O_2$ (vol. 1 cc.). | R |
|---|---|---|---|
| 1—2 | 500 | 10 | Neg |
| 3—4 | 500 | 15 | Neg |
| 5 | 500 | 20 | Sligh ac |

The above experiment was repeated without the solutions. A slight odour was obtained wi 15 mgrms. of acetate, while with 20 mgrms. the fairly strong odour of acetic acid.

*Effect of Dilution.*—To determine the effect o on the sensitiveness of the test another series ments was conducted. The procedure was the that followed in the determination of the sensiti the test, the total volume being 5 cc. instead of 3 results showed that when the volume of the so

he test is made is increased the sensitiveness of is diminished.
:termine the extent to which nitrates interfered e new conditions another series of experiments . The procedure was the same as that followed he volume being 5 cc. instead of 4 cc. The effect .on, as before, is to decrease the sensitiveness of

*Test with Ferric Chloride.*

ferric chloride and an alkali acetate solution are together a reddish brown solution is produced. :s, phosphates, oxalates, tartrates, fluorides, and hinder the free course of the reaction; ferro- mask the red colour, while thiocyanates, iodides, tes offer the most serious interference by forming ns with ferric chloride similar to that of ferric

*nination of the Sensitiveness of the Test.*—To e the sensitiveness of the test for acetates which upon the formation of ferric acetate, a definite of a standard solution of sodium acetate was in a test-tube with 1 cc. N/2 ferric chloride solu- Note), the whole diluted to 5 cc., and the change r of the solution observed. The results are given : III.
:.—In the preparation of the $FeCl_3$ solution no s added. The solution, if cloudy, was filtered sing).

TABLE III.

| lgrms. acetate (vol. 1 cc.). | Result. |
|---|---|
| 1 | Very light reddish yellow. |
| 2—3 | Light reddish yellow. |
| 4 | Reddish yellow. |
| 5-25 | Light reddish brown. |
| 50 | Reddish brown. |
| 100 | Dark reddish brown. |

*nts.*—The test is sensitive to 2 mgrms. of acetate. m. of acetate can be detected by the experienced n the coloration is compared with a blank. With .. a distinct colour is obtained.
*nination of the Extent of Interferences.*—To deter- e extent to which iodides, nitrites, and thio- interfere a series of experiments was conducted. cedure was the same as that followed in the deter- of the sensitiveness of the test. The results l are recorded in Tables IV., V., and VI. In all sts for acetates, nitrites, iodides, and thiocyanates l was run.

TABLE IV.—*Interference of Nitrites.*

| Mgrms. nitrite. | Result. |
|---|---|
| 1 | Pale yellow. |
| 2 | Light reddish yellow. |
| 5—20 | Reddish yellow. |
| 100 | Brownish red precipitate. |

TABLE V.—*Interference of Iodides.*

| Mgrms. iodide. | Result. |
|---|---|
| 1-2 | Yellow. |
| 5 | Light yellowish red. |
| 20—100 | Dark red. |

TABLE VI.—*Interference of Thiocyanates.*

| Mgrms. thiocyanate. | Result. |
|---|---|
| 1 | Blood-red. |
| 2 | Blood-red. |
| 5—100 * | Blood-red. |

*:edure for the Systematic Detection of Acetates.*

e procedure adopted the second and first group e removed by the successive addition of $AgNO_3$ and e of $BaCl_2$ and $CaCl_2$. Any nitrite present is next with $H_2O_2$, and to the concentrated neutral the test with $FeCl_3$ is applied.

*Procedure.*—Render the solution acid with dilute $HNO_3$ and add 5 cc. 10 per cent $HNO_3$ in excess. Add N/4 $AgNO_3$ until precipitation is complete and filter. Render filtrate alkaline with NaOH (see Note), add 10 cc. each of 2N.$BaCl_2$ and 2N.$CaCl_2$ and filter. To the filtrate add 10 cc. 3 per cent $H_2O_2$ and evaporate the solution to 5 cc. At this point most of the salts used as reagents crystallise out. These are separated by filtration. To the filtrate add 1 drop of phenolphthalein solution, and carefully add 5 per cent HCl drop by drop until the colour is *just* discharged. Now add 1 cc. N/2 $FeCl_3$, and compare the colour with control prepared by adding 1 cc. *N/2 $FeCl_3$ to 5 cc. of water.*

(NOTE.—Care should be exercised at this point in avoiding a large excess of sodium hydroxide as it must be neutralised later in the procedure. The excess of Ag is precipitated at this point, but is filtered off together with the Ag salts of the acids of Group 2).

*Test Analyses.*

To determine the reliability of the above procedure a series of test analyses were made. 100 mgrms. of bromide, fluoride, nitrate, nitrite, cyanide, ferrocyanide, ferricyanide, sulphide, sulphite, sulphate, thiosulphate, phosphate, chlorate, carbonate, borate, oxalate, tartrate, chromate, arsenite, and arsenate were respectively introduced into separate beakers, and to each 3 mgrms. of acetate were added. The mixtures were analysed according to the procedure above. The results were all satisfactory. Control tests were also conducted to see if any of the common acid radicals and reagents employed in the separations would give the test with $FeCl_3$. In each case the results were negative, demonstrating the reliability of the ferric chloride test for acetates when carried out according to the procedure described above.

*Summary.*

1. The test for acetates with $H_2SO_4$ (1 : 1) is sensitive to 2 mgrms. Nitrates seriously interfere with the test. In the presence of 500 mgrms. of nitrate the minimum amount of acetate detectable is 20 mgrms.
2. The coloration which $FeCl_3$ gives with neutral solutions of acetates may be employed as a reliable test for acetates, provided the interfering acids are removed and a control run at the same time. The practical limit of this test in pure solutions of acetate is 2 mgrms.
3. A systematic procedure for the detection of acetates in solutions containing interfering acids has been developed.
4. The results of a number of test analyses show the method to be trustworthy.

College of the City of New York,
April, 1920.

## NUTRITION AND PHYSICAL EFFICIENCY.*

By E. V. McCOLLUM, Ph.D.
Professor of Chemical Hygiene, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Md.

(Concluded from p. 207).

IT is significant also that the Chinese peoples, while possessing a civilisation of great antiquity, have lacked certain qualities which are necessary for the formation of a great nation. They were over-run by successive waves of invaders from the north-west during many centuries. The Chinese peoples have lived during all their history on a diet derived from cereals, legume seeds, tubers, fleshy roots and meats, together with a liberal addition of green leafy vegetables and some eggs. The widespread practice of sprouting grains preliminary to their use as human

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foods is justified by the results of modern science. The consumption of a large amount of leafy foods has, I believe, been a factor of the greatest importance in promoting their well-being, for, as has been already mentioned, the leaf of the plant possesses dietary properties very different from those of the seed or other storage organ, and these special properties are just those which are necessary to correct the deficiencies of the seed, tuber, root, or muscle meats. It is perhaps significant in this connection that the Chinese have, on their diet in which the leaf was almost the sole protective food, been unable to cope with their sour milk-drinking neighbours to the north-west. The descendants of these waves of invaders still live in China, forming classes which have never been assimilated socially.

Huntington believes that the climate of China is not of a nature which can make possible the development of a highly progressive race. This does not seem justified without taking into account certain other factors which are of importance in this connection. We must agree upon what conditions are essential to the development of a high state of civilisation before we can agree upon other points.

In a sparsely settled country, where the care of flocks and herds is the only means of livelihood, as is the case over large areas of Asia, pasturage and water are likely to be greatly prized, and the rights to them sharply contested. Enmity between neighbours, lack of education, and the consequent lack of opportunity to gain ideas from others through reading, lack of incentive to do anything other than seek the protection of the animals which contribute to the comfort of man, are themselves reasons enough to account for the lack of development of a high state of civilisation. The climate need not necessarily be responsible for the result. The energy and aggressiveness of peoples who have dwelt in such regions have been repeatedly exhibited in wars of conquest. They have the physical development and intelligence necessary to form the basis of a civilisation, provided the necessary conditions for its growth were existent.

It is necessary, in order that a civilisation may develop, that food, shelter, clothing, and other comforts of life shall be obtainable without too great a drain on the physical resources of man. There are several reasons why these conditions are best fulfilled in the cooler parts of the temperate zones where the rainfall is most satisfactory for the growth of farm crops.

One of these conditions is that the winter in these regions destroys certain insects which would otherwise destroy the crops. Certain disease transmitting organisms, such as the cattle tick and the tsetse fly, which bear respectively the Texas fever and the sleeping-sickness, do not survive the northern winters, and the population in these regions enjoy freedom from these diseases. Cold winters limit the number of species of weeds and other obnoxious plants, and render the production of useful crops less laborious. These are factors of the greatest importance to agriculture and to the well-being of man.

Wherever insect life, such as the destructive ants of tropical forests or myriads of mosquitoes and other insects, detract from the comfort of man, and where rank vegetation renders futile his efforts at clearing ground for cultivation, and where diseases destroy his domestic animals, and place in his own blood disease-producing organisms which rob him of his vitality and ambition, man must have recourse to power other than his own strength to overcome his obstacles. If we give him the aid of machinery and control over suitable sources of power to free him from his crushing burdens, and the aid of science to free him from the scourge of disease, and a diet which causes him to develop a high state of physical perfection, then we may confidently expect of him any development of mental traits consistent with his heredity. It is the aim of those who direct the great agencies for the promotion of hygiene and public health to bring to the inhabitants of the tro

faith that these inhospitable regions can ulti
made the seats of creditable human societies.
all of these problems have been solved will ma
in the less hospitable parts of the world.

One not infrequently sees in discussions of t
the statement that in the warm regions of t
where food is easily obtainable, and little shelte
ing is necessary to the comfort of man, he sinks
lence, and remains in a state of ignorance and d
It is urged that only in such a climate as n
exertion and foresight during the summer in
provide food, shelter, and clothing with which
severe winter in comfort, will man develop in a s
way the higher virtues of civilisation. The t
been postulated that energy, aggressiveness,
foresight, inventiveness, solicitude for depender
for property rights and the other virtues of man
highly advanced condition, are best fostered in
which offers vicissitudes, and requires that the
individual shall be a struggle with his environm

We are also told by others, and it appears to
so long as man is forced to spend his days in
for existence he cannot develop his higher menta
It is said that the creation of an aristocratic
society, whose wants are supplied by the labou
fice of a less fortunate group, establishes the id
tion for fostering the mental growth which co
reflection and the study of the ideas of others.

There is doubtless an element of truth in eac
views regarding the conditions under which man
develop his mental capacities. Leisure is e
certain types of creative thought. Thought is
profoundly through discussion, reading, and ol
of the phenomena of nature. It is not yet dem
however, that such creative thought is possible
only in temperate regions where there are fre
pronounced changes in temperature.

Let us now return to the relation of the diet
efficiency. We have, I believe, a very importa
to solve in the education of the public in man
the United States in the proper selection of foo
are large numbers of people who are living too
diets derived almost exclusively from wheat f
meal, and polished rice, all of which represent t
parts of the kernels from which they are man
together with tubers such as the potato and swe
and edible roots such as the beet and turnip, sup
with muscle cuts of meat. This type of diet is
factory for the nutrition of an animal unless it
mented with milk or the leafy vegetables in libera
Of somewhat lesser value as corrective foods ar
the glandular organs of animals. These, are
very low in calcium and so fail to make good this
fault in the diet.

Early ageing and low vitality with consequen
bility to disease attend the adherence to an uns
diet. This conclusion has been forced upon my
and myself as the result of thousands of obser
animals restricted to diets varying in quality and
as to source. Variety, palatability, and a
chemical composition as revealed by the best r
analysis at our disposal do not necessarily guaran

There is still some scepticism among though
as to the importance of diet in its relation to l
disease. This is the natural result of several fa
the first place we accept as normal such con
nutrition as we are accustomed to, until it is dem
that a higher standard is easily attainable. We
tomed to see people old looking at thirty or for
age, and do not become impressed by it, even
occasional preservation of vigour to an adv
shows us what is possible.

The results of malnutrition are not such a
themselves on the attention. It is attended b
but not by pain. The effects of heredity and

hich is scarcely distinguishable from that due to utrition. Man in different regions lives on diets are widely different in character, and succeeds ntly well to seem to warrant the conclusion that it little difference what kind of food he takes so long s wholesome and he has enough. The fallacy of n assumption becomes apparent in the light of what w know of the dietary properties of each of the more ant natural food stuffs. We can readily see now an in different parts of the world is living on all the of diet on which it has been found possible to nourish ls, and on no other. In certain places he is attempt- live on diets which cost him his vitality by the time reached an age which should find him enjoying the gour of middle life. This is the seed, tuber, and type of diet which has already been described.

oughout parts of India, China, Japan, the Philip- eastern South America, Newfoundland, and dor, *beri-beri is common, and is due to faulty diet of* acter which we well understand. Those who live t *exclusively on a diet of degerminated seed pro-* , tubers, roots, and muscle meats do not miss by a *wide margin developing this disease.*

ile scurvy has become a relatively rare disease among s, it is still common among infants which are fed heated milk as their sole food. We now know that ntiscorbutic substance, water-soluble C, is the most ble complex in the diet, and is readily destroyed by ng to the boiling point of water. It is certainly true many people who live almost exclusively on cooked come very near the point of specific starvation for articular substance, and narrowly escape developing isease.

. Goldberger, of the Public Health Service, has done ble work in the study of the relation of the diet to gra in the South. He has pointed out that the diet pellagrin consists essentially of degerminated cereal s, starch, sugar, molasses, sweet potatoes, and fat . But a very small amount of green leafy vegetables aten and practically no milk. He has improved the of the inmates of institutions where pellagra was a ge, *and observed that this leads to the eradication of* lisease. He and his associates were not able to con- *the disease by material from the lesions from pella-* and with their excreta while the experimenters were g *on a satisfactory diet. Further dietary studies* in villages where pellagra was common showed that e families which used liberal amounts of milk very ly contract the disease, and its incidence is highest in e households where least milk and green vegetables used as food. The liberal use of the articles which as result of animal experimentation have been discovered e corrective in character prevents the occurrence of agra. The question as to whether it is a disease due n infectious agent has not been definitely decided.

is significant that the incidence of tuberculosis among general population of a city such as Baltimore is very h higher among the group of people who live almost usively on the bread, meat, and potato type of diet, use least milk and green vegetables. If we may ly draw deductions from animal experimentation it ears probable that this diet predisposes these people to ction with the tubercle organism.

lany will not agree with this conclusion, but hold that r *hygienic conditions and opportunity for infection,* al susceptibility, and certain trades, are the factors ch *make this disease common. To this view I would* ly that we know that the diabetic patient, whose vitality owered both *by failure of one of the normal processes* metabolism—the oxidation of sugar—and by faulty , as is practically always the case, is extremely suscep- e to tuberculosis. The medical profession has for many rs recognised that one of the most valuable therapeutic nts in this disease is good nutrition. It is interesting note that on purely empirical grounds the profession g ago came to the employment of a diet for the tuber- cular which contained liberal amounts of milk and eggs.

A group of people which is of special interest in connec- tion with the *problem of susceptibility to tuberculosis, is* the non-citizen Indian of to-day. There is no group of people anywhere who are dying more rapidly from tuber- culosis. They live out-of-doors all summer, and probably have, throughout the year, as much fresh air as the average city dweller. They do have abundant opportunity for becoming infected because of their careless association with infected persons, and reckless dissemination of infected sputum. Racial susceptibility has been generally regarded as a satisfactory explanation of the prevalence of tuberculosis among these Indians. It seems to me that there is another and more important factor involved, the unsatisfactory character of their food supply. The non-citizen Indian lives on a reservation and is supported by the government. He has, in general, no interest in agriculture, and does not raise much of his food. His live stock usually consists of horses. He lives on the *products which he buys at the agency stores, and these,* unfortunately, consist almost wholly of degerminated *cereal products, legume seeds, tubers, and meats.* It seems plausible at least that this diet is an important *factor in rendering him susceptible to this rather mildly* virulent infection.

In the light of modern nutrition studies we have come to regard as unsatisfactory some of the diets widely used by man. We have demonstrated in certain respects that there is a close parallelism between the history of a poorly nourished animal and a poorly nourished man. Much remains to be learned of the finer details of the dietary habits of man in various parts of the world, and of the health conditions with which these can possibly be corre- lated. It has seemed, however, that we have succeeded in correlating certain data relating to human nutrition with the results of laboratory studies in a manner which brings to light a most important principle in the selection of foods. If these deductions are sound it is evident one of the great tasks of the general undertaking of raising the standard of public health is the education of the public *along two lines. One of these is to extend the use of* dairy products, and the other is the cultivation of the *habit of eating much more freely of green leafy vegetables* than is now the practice anywhere in the United States.

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## BISMUTOPLAGIONITE, A NEW MINERAL.*

By EARL V. SHANNON, U.S. National Museum.

SOME specimens forwarded to the U.S. National Museum for examination and report by Mr. Tim McCarthy, of Wickes, Montana, contained a grey metallic mineral which was identified by Mr. W. F. Foshag as a sulphide of lead and bismuth. As the mineral appeared to be of more than ordinary interest, the sender was asked for a sufficient quantity of the material for detailed investigation which, when received, was turned over to the writer for study. Enough of the grey bismuth mineral was secured for an analysis which indicated that the mineral is a new species having the composition of a plagionite in which the antimony is almost entirely replaced by bismuth. The name bismutoplagionite indicates this chemical relationship.

Nothing is known regarding the locality of the mineral other than that the specimens were sent from Wickes, Montana, but it is presumed that they came from somewhere in that immediate vicinity. Wickes is a small mining town in Jefferson County, about ten miles southwest of Helena.

The specimens consist in large part of coarse granular pyrite, each grain being a well-defined cubic crystal with the corners truncated by octahedral planes. The bismuth mineral occurs in small, indistinctly fibrous masses intergrown with pyrite in aggregates up to one inch in diameter. Much of the ore contains a soft, scaly, micaceous mineral apparently sericite. The masses of pyrite contain also in places small masses of galena, tetrahedrite, and chalcopyrite, and small prismatic crystals of transparent to milky quartz.

In appearance the new mineral does not differ from many of the other sulphosalts of lead. In colour it is slightly bluish lead-grey. The aggregates are indistinctly fibrous, the fibres curving around pyrite or quartz crystals, which, when removed, leave moulds in the bismuth mineral. There is a rather ill-defined cleavage parallel to the elongation. In one specimen a small cavity between pyrite crystals contained brilliant, deeply striated prisms of the mineral, but these were not terminated and were too minute for measurement. The specific gravity of the mineral is 5·35; hardness 2·8; streak, dark brownish-grey, dull. Before the blowpipe alone on charcoal, it fuses to a brittle globule and yields a coating which is yellow nearest the assay and white in its outer portion. With sodium carbonate, is reduced to a metallic button yielding similar coatings on the coal. In the closed tube, yields a copious sublimate of sulphur; in the open tube, gives abundant sulphur dioxide and, at a high temperature, a heavy sublimate which is yellow while hot and yellowish white when cold. With potassium-iodide-sulphur mixture yields the usual bismuth reaction.

The mineral for analysis, which was free from impurities other than pyrite, was completely dissolved in hot concentrated hydrochloric acid while the pyrite remained for the most part undissolved. The portion given as insoluble in the table below consisted almost entirely of pyrite. Upon analysis the powdered mineral gave the following results:—

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*Bismutoplagionite, Montana.*

| | |
|---|---|
| Insoluble .. .. .. .. | 18·88 |
| PbS .. .. .. .. .. | 30·21 |
| $As_2S_2$ .. .. .. .. .. | trace |
| CuS .. .. .. .. .. | trace |
| $Ag_2S$ .. .. .. .. .. | trace |
| $FeS_2$ .. .. .. .. .. | 1·25 |
| $Sb_2S_3$ .. .. .. .. .. | 3·37 |
| $Bi_2S_3$ .. .. .. .. .. | 45·62 |
| Total .. .. .. | 99·33 |

Deducting impurities and recalculating to 10[0] this gives:—

| | |
|---|---|
| PbS .. .. .. .. .. | 38·13 |
| $Sb_2S_3$ .. .. .. .. .. | 4·26 |
| $Bi_2S_3$ .. .. .. .. .. | 57·61 |
| Total .. .. | 100·000 |

These values yield the following ratios:—

| | | | |
|---|---|---|---|
| PbS .. | 0·1594 or | 15·94 or | 5·04 |
| $Bi_2S_3$ .. | 0·1125 } | 12·65 | 4·00 |
| $Sb_2S_3$ .. | 0·0140 } | | |

The new mineral thus agrees almost exactly [with the] formula $5PbS.4Bi_2S_3$, a small proportion of th[e bismuth] being replaced by antimony. Although but [one] analysis was made it is considered improbable [that the] mineral can be regarded as a variety of galenob[ismutite]. The sample analysed was selected with extrem[e care by] hand picking, each fragment being examined [under the] microscope, and chunks of the sulphide aggreg[ate which] showed any minerals other than pyrite and th[e] bismuth mineral were not crushed in the lot fr[om which] material for analysis was picked. It was nec[essary to] determine sulphur by difference, but the va[lue] obtained is almost exactly that required to co[mbine the] metals to their respective sulphides. The iron [found in] solution is deducted as pyrite. It is surprising [that the] pyrite was not more completely attacked by [the] treatment with hot hydrochloric acid to which it [was sub]jected.

Plagionite, despite its unusual ratios, is a m[ineral of] definite composition and form, and that it shoul[d have a] bismuth analogue is to be expected. The two are isomorphous as indicated by the small antimon[y content] in the present mineral. Liveingite (*Min. Mag.*, 1...) also seems to be a well-defined member of t[he] group. The formulæ of the three members of th[is] diate group are then:

| | |
|---|---|
| Plagionite .. .. | $5PbS_4Sb_2S_3$ |
| Bismutoplagionite .. | $5PbS_4Bi_2S_3$ |
| Liveingite .. .. | $5PbS_4As_2S_3$ |

The composition given in the analysis with the a[ntimony] recalculated to bismuth is compared with the th[eoretical] composition of the bismuth compound and with g[alenobis]mutite in the following table:

| | I. | II. | III. |
|---|---|---|---|
| PbS (per cent) | 37·34 | 36·87 | 31·83 |
| $Bi_2S_3$ (per cent) | 62·66 | 63·13 | 68·17 |

I. Analysis of bismutoplagionite, Sb calcu[lated to] Bi and the whole reduced to 100 per ce[nt].
II. Composition to satisfy formula $5PbS_4Bi_2S$[$_3$].
III. Galenobismutite, composition to satisfy PbS,$Bi_2S_3$.

—*American Journal of Science*, March, 1920.

## REFRACTORIES.

P. S. Devereux, a co-worker with Dr. Mellor, dis-sed "*Refractories*" at a well attended meeting of the mingham Metallurgical Society at the Chamber of nmerce on Thursday, April 15.

Ie pointed out that as regards the common character- possessed by all refractory materials, that of resistance high temperature, the initial problem presented for erimental investigation is to a large extent a problem physical chemistry, involving as its most important ture the application of the phase rule and the laws of itions. Thus, in accordance with the known laws of sical chemistry, the effect of the presence of impurities refractory material is always to decrease the refrac- power, *except when the proportion of the impurity is* arge as to cause the composition of the mixture to coin- with a maximum in the phase diagram for the system, ler which conditions the effect of the "impurity" may either a decrease, an increase, or no change at all in refractory power, depending upon the materials involved. ese principles are also violated in the rather widespread a that as a general rule the refractory power of a given terial can be increased by mixing with it a second more actory material. Thus it is commonly supposed that addition of silica to a fire-clay makes it more refractory en as a matter of fact the softening point is lowered. en in text-books and treatises on ceramic subjects the ious formulæ given for calculating the softening point a mixture from its components seem to have been nulated without regard to established physico-chemical s.

The more silica there is in a fire-clay, said Mr. Devereux, better it resists under a load. With regard to the ening of bricks in actual furnace practice, near the nbustion chamber, a rather soft brick is best as it serves a protection against permeation and throws the strain he load on to the cooler parts of the brick. Graphite cibles usually have to bear a great weight, and the ding clay *is most important*; *Klingenberg* clay is the t, Dorset ball-clay being nearly as good. The low conductivity of chromite bricks is their chief attribute, not diminishing even at high temperature. An ore ning from 40 to 50 per cent chromic oxide and from 7 per cent silica makes the best refractory. Bauxite alumina bricks have not had a fair chance. While stant to slags they must be prevented from high inkage by high firing first. The great trouble with gnesite bricks is their tendency to crack, flake, and l at high temperatures. Magnesia from calcined gnesite occurs in two different forms, one of which a lower specific gravity of 3·2 and is more chemically ve than the other form with specific gravity of 3·7. ere was thus a shrinkage caused by this change from to high specific gravity. This should be effected in manufacture of the bricks, but the conversion is never nplete even if the firing is continued well over 1650° C.

Dolomite is of course initially a cheaper refractory than gnesite. There is no doubt that although the rapid elopment of the electric furnace has been abnormal it yet been retarded by want of suitable higher refrac- es to meet the excessively great temperatures required, have at the same time the many other desired heat, ngth, and dielectric *properties*. *Pure magnesia* does liquefy until a temperature of 2800° C. is attained. If quantities of alumina, no matter how small, and not eeding 70 per cent, be mixed with the magnesia the elaction drops from 2800° to 2030° C. By mixing ether magnesia and alumina in the proportion of 72 of $O_3$ to 28 of magnesia, the compound magnesium ninate will form even at temperatures considerably w its melting point. The formation of this compound ally results in a mass of small interlacing crystals and sequently gives a product of increased mechanical ngth and toughness.

a to the testing of refractory materials, said Mr. Devereux, it is important that the methods be standardised. A provisional specification has been prepared by a committee of the Refractories Section of the Ceramic Society. Methods have been laid down for analysis, determination of porosity, shrinkage on drying and firing, tensile strength after contraction and expansion, refrac- toriness with and without load, the thermal or reversible expansion, crushing strength, corrosive and abrasive action of flue-dust, degree of fineness of clays, and the penetrative action of slags.

# PROCEEDINGS OF SOCIETIES.

## ROYAL SOCIETY.

*Ordinary Meeting, April 22, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read:—

"*Experiments on the Pressure Wave Thrown out by Submarine Explosions.*" By H. W. Hilliar.

A method is described for determining the time-pressure curve at a given point in water in neighbourhood of an exploded charge. The method depends, in principle, on measuring the growing velocity of a short steel piston exposed at one end to pressure in water. This method was applied in a comprehensive deep-water investigation of pressure waves springing from a great variety of charges. Comparisons were made between various kinds of explo- sive, including gunpowder, which gives results remarkably different from those yielded by high explosives.

The general behaviour of the pressure-wave was found to approximate closely to that of a sound wave. Its velocity was measured directly and found not to differ sensibly from that of sound in sea-water (4900 feet sec.). The pressure falls off in approximately simple proportion to distance from charge. The influence which the water surface exercises on pressure at a given point can be accounted for by supposing that the pressure wave is re- flected from the surface as a tension wave. The first part of the pressure wave arrives at the point in question entirely unaffected by proximity of surface; but after a certain interval, determined by the difference in length of direct and reflected paths, the remaining pressure is obliterated by the arrival of the tension wave.

The pressure wave from a big charge is more intense and more sustained than that from a small charge, the two waves being connected by a definite relationship deduced from the principle of dynamic similarity. If pressure waves from a big and small charge are compared at distances proportional to the linear dimensions of the charges, the maximum pressure is the same in both cases, but it decays at a rate inversely proportional to the linear dimensions. Other questions examined include effect of surrounding charge with large air-space, effect of exploding charge on sea-bottom instead of mid-water, influence of shape of charge as affecting symmetry of pressure wave, and reflection of wave from sea-bottom.

"*A Study of the Catalytic Action at Solid Surfaces. III. The Hydrogenation of Acetaldehyde and the Dehydro- genation of Ethyl Alcohol in the Presence of Finely- divided Metals.*" By E. F. Armstrong and T. P. Hilditch.

*Hydrogenation of Aldehyde.*

Aldehyde may be converted into alcohol by passing the vapour together with hydrogen over either copper or nickel (Sabatier); but in presence of the latter metal, probably owing to the special affinity of nickel for the carbonyl group, the aldehyde is prone to undergo decom- position into carbon monoxide and methane.

Copper at 200–220° effects reduction of aldehyde to alcohol smoothly, but at 300° about 50 per cent of the aldehyde disappears and but little reduction is effected, the recovered aldehyde and alcohol being in about equal amounts.

If the point of equilibrium reached had been the same as in proceeding from the dehydrogenation side, about 75 per cent of the aldehyde should have been transformed to alcohol, and the loss of aldehyde should not have exceeded about 5 per cent; at least it might have been expected that the amount of aldehyde recovered would have been less than that of the alcohol formed.

*Dehydrogenation of Alcohol.*

The yield of aldehyde obtained from alcohol as dehydrogenated in the presence of nickel is only 35 per cent, whereas in the case of copper, not only is the ratio of aldehyde to hydrogen close to that calculated, but the unchanged alcohol may be recovered almost quantitatively, the yield of aldehyde being about 90—95 per cent of that to be expected from the amount of alcohol used. There is a striking absence of the secondary products observed when aldehyde together with an excess of hydrogen is passed over the metal at the same temperature.

In addition, we find that the presence of water improves the yield of acetaldehyde relatively to that of hydrogen.

The general explanation of the changes studied appears to us to be the same as that suggested in our previous communications with reference to simple ethylenic compounds.

"*A Study of the Catalytic Action at Solid Surfaces. IV. The Interaction of Carbon Monoxide and Steam as Conditioned by Iron Oxide and by Copper.*" By E. F. ARMSTRONG and T. P. HILDITCH.

It is shown that, like certain forms of iron oxide, prepared copper is able to effect considerable transformation of carbon monoxide and steam into carbon dioxide and hydrogen. Whereas, however, iron oxide at a suitable temperature causes the action to proceed almost as far as the equilibrium constant permits, copper does not at its *optimum* temperature effect more than 50—70 per cent of the possible amount of chemical change; the exact proportion is to some extent a function of the composition of the original gas employed.

The action of copper commences at a little over 200° C., and up to 300° is greater than that of an iron oxide catalyst, the latter being without appreciable effect below 250° C.

The difference in behaviour is explained by the hypothesis that copper effects a decomposition of formic acid (momentarily produced from carbon monoxide and steam) into carbon dioxide and hydrogen from 190° C. upwards, whereas the iron oxide alternately oxidises carbon monoxide, and is in turn in its reduced form reoxidised by the action of steam.

These results are of interest, from the point of view of the general theory of catalysis which we have lately put forward, as illustrating the specific action of two different types of catalyst, which produce ultimately the same change ($CO + H_2O = CO_2 + H_2$), but by an entirely different mechanism, involving production of intermediate systems of quite distinct kinds.

"*On the Structure of the Balmer Series of Hydrogen Lines.*" By T. R. MERTON.

In a previous investigation with Prof. J. W. Nicholson it was found that the separation of the components of the lines $H\alpha$ and $H\beta$ suggested that the series should be regarded as a principal series. It is now found that the structure of these lines is not invariable, but is altered by the presence of impurities, notably helium, in vacuum tubes containing hydrogen.

The optimum conditions of sharpness were found in hydrogen mixed with an excess of helium and cooled to the temperature of liquid air, and under these conditions the separations of the components approximate to those appropriate to a diffuse or sharp series. The app of the lines in the purest obtainable hydrogen is different. Measurements have been made of the tions of the components under the optimum condi resolution with the aid of an échelon diffraction and the physical widths of the lines and the intensities of the components have been deduced fr measurements.

It is suggested that the structure of the lines is c the relative intensities of the components being under different conditions; the structure suggeste appear to be consistent with Sommerfeld's theore vestigations and with the results of experiment.

"*Diamagnetism Due to Free Electrons.*" By WILSON, F.R.S.

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*Ordinary Meeting, April 29, 1920.*

Sir J. J. THOMSON O.M., President, in the Ch

THE following papers were read:—

"*The Irish Eskers.*" By Prof. J. W. GREGORY,

Eskers are banks of sand and gravel, typically oc as ridges on the central plain of Ireland, where the deposited during the recession of the ice at the cl the glacial period. They have been generally att to deposition along glacial rivers, like Swedish Their structure and composition indicate that the important Irish eskers were formed along the ma the receding ice sheets by floods of water, due melting of the ice.

Irish eskers formed along glacial rivers are rel small and exceptional. The accumulation of the ma into ridges, and their restriction between about 15 300 feet above sea-level, are attributed to the forma the eskers where the ice entered into a sheet of which was probably the sea, since marine fossi widely distributed in the adjacent drifts, and there embankments to maintain glacial lakes at the re level.

It is proposed that the term esker should be con for Irish ridges and mounds of sand and gravel, bu in glacial geology the term *osar* should be used for formed along the course of glacial rivers, and *kame* for ridges deposited by water along the margin of sheet.

"*The Life-History and Cytology of* Synchytrium en ticum *(Schilb.) Perc., the Cause of Wart Disease in Po* By Miss K. M. CURTIS.

The life-history and cytology of the organism has followed throughout all its stages. In the course investigation the following important points have determined: (1) a sexual process has been discovere followed in all its details; (2) the nature of the diffe between the resting (or winter) sporangia and the s summer sporangia) has been established; (3) the inf of the host tissue by the zoospores and zygotes has traced; (4) the peculiarities in the behaviour of the nu of the parasite have been investigated.

The resting sporangium continues development the decay of the host-tissue, and gives origin to num uninucleate zoospores, which show a well-marked blep plast. These ultimately come to rest on the surfa of the host, and are able to enter the epidermal cell o actively dividing tissue. In the process of entr zoospore is closely adpressed to the surface, and put a peg-like projection (with which the nucleus is associ which forces its way through the host cell wall, parasite after entry becomes the prosorus, which in size. Five to seven sporangia compose the so sorus. The sporangia liberate motile cells, which hitherto been described as zoospores. They are sm than the zoospores from the resting sporangia, bu

erwise similar. They behave as facultative gametes; they may either fuse together and produce a zygote, which later infects the host, or they may remain unfused and behave as zoospores. The result of infection by a zygote is a resting sporangium; the result of infection by unfused gamete is a sorus.

In the prosorus normal mitosis with five minute spherical chromosomes is to be observed. In the resting sporangium mitosis is absent, the nucleus disorganises, and the zoospores arise from chromatic granules which appear in the cytoplasm.

"*On the Structure and Affinities of* Acmopyle pancheri, *Pilger.*" By B. SAHNI.

*Acmopyle*, a monotypic New Caledonian Podocarp, is the most specialised member of the Podocarpineæ, and closely allied to the genus *Podocarpus*, which it resembles in the vegetative anatomy, drupaceous seed, megaspore membrane, young embryo, structure of male cone, microsporophyll, pollen-grain, and probably male gametophyte.

It differs from *Podocarpus* in (1) the nearly erect seed; (2) the complete fusion of the epimatium to the integument, even in the region of the micropyle, in the formation of which it takes part; (3) the much greater development of the vascular system of the seed, which forms a nearly continuous cup-like tracheal investment, covering the basal two thirds of the stone.

(*a*) The Taxineæ are structurally so distinct from the remaining Conifers as to justify their being placed in a separate phylum, Taxales, equivalent in rank, and related to the Ginkgoales and the Coniferales as here defined. The Cordaitalean affinities of the Taxales are emphasised.

(*b*) Concerning the ovuliferous scale of the Conifers, the conclusion is in favour of the Brachyblast Theory, support for this view being derived from the structure of the megastrobilus of *Acmopyle*.

(*c*) No definite opinion is expressed on the question whether the Conifers arose ultimately from microphyllous or megaphyllous ancestors, for the origin of the Cordaitales themselves is still regarded as *sub judice*. It is recognised that, considering the available positive evidence, the megaphyllous theory rests on a firmer basis than the microphyllous theory. At the same time, emphasis is laid on certain facts of a negative nature, which are, pending further evidence, regarded as obstacles in the way of an unqualified acceptance of the megaphyllous theory.

## SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

*Ordinary Meeting, May 5, 1920.*

Mr. ALFRED SMETHAM, President, in the Chair.

A CERTIFICATE was read for the first time in favour of Mr. Udolphus Aylmer Coates.

Certificates were read for the second time in favour of Misses Dorothy Gertrude Hewer, B.Sc. (London); Rita Catherine Hawkins Johnson; Messrs. Harold Hall, F.I.C.; Geoffrey Trelawney Bray, A.I.C.; Frank William George King; John Herbert Stubbs, M.Sc. (Victoria), F.I.C.

The following were elected Members of the Society:—Messrs. Laurance Harry Mills, B.Sc. (Birmingham), A.I.C.; Frederick Robertson Dodd, F.I.C.

Papers, of which the following are abstracts, were read:

"*A Volumetric Method of Estimating Iron.*" By H. DROOP RICHMOND, F.I.C., and EDITH M. ISON, B.Sc.

The method described by the authors is applicable in the presence of hydrochloric acid, phosphorus oxy-acids, and organic matter, and was devised primarily for the estimation of iron in syrups. Colouring matter is destroyed and the iron converted to the ferric state by means of potassium permanganate in the presence of hydrochloric acid. Strong hydrochloric acid and sodium bicarbonate are then added to produce a $CO_2$ atmosphere, and the ferric iron then titrated with N/10 stannous chloride, using thiocyanate as indicator. The paper includes detailed hints upon the manipulation of the method.

"*Estimation of the Age of Ink in Handwriting.*" By C. A. MITCHELL, M.A., F.I.C.

The author deals with the importance of knowing dates of alteration in composition of inks, and describes the various compositions. He distinguishes between old and modern inks and artificial imitation of old inks. Changes during oxidation and methods of recording changes of colour are dealt with, also copying methods of estimating age, chemical tests, and artificial ageing of inks. Various law cases bearing on the points dealt with are mentioned.

"*The Examination of Chinese Crude Camphor.*" By E. R. DOVEY, A.R.C.S., A.I.C.

The amount of camphor oil present is determined by submitting a 100 grm. portion to pressure in a steel press and from the weight of the pressed cake the loss of water and oil is found. The moisture is determined on the original sample and also on the pressed cake by the calcium carbide or other method, and by difference the weight of water lost in pressing is found. This subtracted from the total liquid expressed gives the amount of oil expressed. It is assumed that the water remaining in the sample is associated with as much oil as that in the expressed liquid, and the total oil present calculated on that basis.

## NOTICES OF BOOKS.

*Fuel Production and Utilisation.* By H. S. TAYLOR, D.Sc. (Liverpool). Pp. xiv+297. 1920. London: Baillière, Tindall, and Cox, 8, Henrietta Street. Price 10s. 6d. net.

THIS book belongs to the "Industrial Chemistry" series edited by Dr. Samuel Rideal.

The author's aim is to supplement the academic training of the young college graduate with the broad facts of fuel production and utilisation.

After an introductory chapter on the physical chemistry of fuel, the author gives us a thorough research into the uses to which coal and its by-products are put to as a fuel.

Section I. is a treatise on the direct combustion of coal, including its chemistry, engineering features, and economics of the trade. This section also contains an article on briquettes and their manufacture.

The destructive distillation of coal is dealt with in Section II.

Section III. deals with the economic uses of coke in the iron and steel industry and for steam raising. Blast furnace gas and water-gas are also included under this section.

Section IV. gives a very good account of the manufacture and uses of producer gas.

Section V. deals with the use of carbonisation residues of coal distillation as fuel.

The next three sections respectively deal with the use of lignite, peat, and wood as fuels.

The book is well written and should be of great value to those whose daily work brings them in contact with fuels, either their manufacture or utilisation.

*Chemists' Manual of Non-ferrous Alloys.* By J. DOWNIE, F.C.S. Pp. vii+168. 1920. London: E. and F. N. Spon, Ltd., 57, Haymarket, S.W. 1. Price 10s. net.

THE author has endeavoured in this "Chemists' Manual of Non-ferrous Alloys" to arrange his matter to the benefit of the experienced analyst and at the same time

remember the beginner. Is this necessary? For a manual is a handbook in which information should be found to supplement or to revive knowledge already acquired.

The first three chapters on the laboratory and its fittings are very elementary, so much so that it is a wonder they have been put in; for in any case, the beginner who has arrived at the stage of analysing alloys would have knowledge of a ring burner or a desiccator! Illustrations of apparatus used are given, some of which err in clearness.

Chapter IV. deals with the detection of metals. In the first place a list of characteristic reactions is given of the well known metals. Following on this is a scheme for the qualitative examination of an alloy on the lines of the old "group" analysis. The chapter ends with a selection of the special solutions and gases required and their making up.

The remainder of the book gives various methods of estimating metals; first, by gravimetric means; secondly, by volumetric means; and thirdly, by colorimetric observations.

The methods of estimating metals gravimetrically are divided into two series—(1) when only one metal is present, and (2) when a separation from another metal is necessary.

The chapter on volumetric estimations gives, first, methods of making up standard solutions with factors and indicators used, then a series of methods for estimating all the well-known metals.

Chapter VIII. gives a series of methods of estimating metals present only in very small quantities by colorimetric means.

In Chapter IX. the author gives methods for estimating impurities present in commercial metals, and in the following chapter methods for estimating the commoner alloys are given.

The analyses of coal, waters, and fireclay are discussed in Chapter XI. For the estimation of mineral matter in water the author states that the method adopted should be to estimate the total solids by evaporating down a known volume on a water-bath to constant weight, then to ignite this residue for the mineral matter. The difference of these two figures gives the organic matter. Surely he has forgotten the loss of carbon dioxide by certain alkaline earths at high temperatures, also some salts do not totally lose their water of hydration at 100° C.

In determining the calorific value of a coal the Lewis Thomson calorimeter is mentioned. This method has long been superseded by the bomb calorimeter, which gives far more reliable results.

An appendix of useful data is given, in which are included analyses of the commoner alloys.

## BOOKS RECEIVED.

"A Text-book of Inorganic Chemistry." Vol. IX., Part I. By J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C. Pp. xviii+367. 1920. London: C. Griffin and Co., Ltd., Exeter Street, W.C. 2. Price 18s.

"Chemistry Lecture Notes." By G. E. WELCH, M.A., B.Sc. Pp. iv+63. London: Blackie and Son, 50, Old Bailey. Price 2s.

"Elementary Practical Chemistry." 2nd Edition. By J. E. MYERS, D.Sc. (Vict.), A.I.C., and J. B. FIRTH, M.Sc. (Vict.), A.I.C. Pp. viii+194. 1920. London: C. Griffin and Co., Ltd., Exeter Street Street, W.C. 2. Price 4s. 6d.

"Manual of the Chemical Analysis of Rocks." By HENRY S. WASHINGTON, Ph.D. 3rd Edition. Pp. xii+271. London: Chapman and Hall, 11, Henrietta Street, W.C. 2. Price 11s. 6d. net.

THE Autumn Meeting of the American Chemical Society ill be held in Chicago, September 7 to 10, 1920, clusive.

## CORRESPONDENCE.

### THE STRUCTURE OF MATTER AND QUANTUM THEORY

*To the Editor of the Chemical News.*

SIR,—With your kind permission I should like to few corrections in my paper the conclusion of wh peared last week.

In Part II, p. 195, top of 2nd par. from the bo right-hand column, *previous paragraphs* should *penultimate paragraph.*

In Part IV., p. 218, Note 11, 2nd and 3rd pars., gen and nitrogen *atoms* are referred to; and in 4 from bottom in right-hand column the sentence be with *extending* should read—Extending the princi volved and assuming that for every $B_{\alpha}H$ molecul $B_{\beta}H_3$ molecules are formed, the summation become

In the par. below, containing a large summation of cules, $3B_{\gamma}H$ should read $3B_{\alpha}H$.

Referring to the $\gamma$-isotope (diagram p. 218) it sho noted that this is an *alternative* type to the $\delta$-isotyp which might be referred to as a C-type to disting from either a ring (neon) or a straight line type.

Na may be added to the list of elements shown 218: in the first line of course.—I am, &c.,

F. H

## NOTES.

ROYAL INSTITUTION.—The Annual Meeting of the bers of the Royal Institution was held on May James Crichton-Browne, Treasurer and Vice-Preside the Chair. The Annual Report of the Committ Visitors for the year 1919, testifying to the cont prosperity and efficient management of the Institu was read and adopted, and the Report of the D Faraday Research Laboratory Committee was also Sixty-four new Members were elected during the year sixty-two Lectures and nineteen Evening Discourses delivered. The books and pamphlets presented amo to 193 volumes, making with 399 volumes (incl periodicals bound) purchased by the Managers, a to 592 volumes added to the Library in the year. Th were voted to the President, Treasurer, and Secretar Committees of Managers and Visitors and to the fessors, for their valuable services to the Institution d the past year. The following gentlemen were unanim elected as Officers for the ensuing year: President— Duke of Northumberland; Treasurer—Sir James Crich Browne; Secretary—Col. Edmond H. Hills; Manag Dr. Horace T. Brown, J. H. Balfour-Browne, Joh Buchanan, W. A. Burdett-Coutts, Sir James J. Dol Dr. J. Dundas Grant, Dr. Donald W. C. Hood, Right Hon. Earl Iveagh, H. R. Kempe, Sir Ernest M The Hon. Sir Charles Parsons, Sir James Reid, Bart., Ernest Rutherford, The Right Hon. C. Scott-Dickson Henry Wood. Visitors—Sir Hugh Bell, Bart., Sir Wil H. Bennett, W. R. Bousfield, John G. Bristow, F Clowes, Montague Ellis, W. E. Lawson Johnston, J R. Leeson, Thomas Bell Lightfoot, F. K. McC William Smith Norman, Hugh Munro Ross, Jo Shaw, Thomas H. Sowerby, Sir Almroth Wright.

AT the Annual General Meeting of the Chemical Sec of the Manchester Literary and Philosophical Soci held on April 30, 1920, the following Officers and M bers of Committee were elected for the session 1920 2 Chairman, Mr. J. N. Lester; Vice-chairman, Mr. R. Clayton; Hon. Secretary. Mr. David Cardwell; C mittee—Dr. Edward Ardern, Mr. F. W. Atack, Dr. H. Bentley, Prof. Arthur Lapworth [illegible]

of. F. Lee Pyman, Miss Rona Robinson, Mr. L. Vies, and Mr. T. R. Wollaston.

INSTITUTE OF CHEMISTRY.—PASS LIST, APRIL (1920) (AMINATIONS. The results of the examinations of the stitute recently held in London, Manchester, and effield have now been published. The following candites were successful:—For the Fellowship: In the anch of Organic Chemistry—R. O. Eames, B.Sc. Vales) and H. W. B. Clewer; In the branch of the emistry of Food and Drugs, Fertilisers and Feeding uffs, Soils and Water—Norman Ratcliffe; in the branch the Chemical Technology of Textile Manufacture— Clayton. For the Associateship: In the branch of ganic Chemistry—E. C. Pickering B.Sc. (Lond.) and B. Phillips; in the branch of the Chemistry of Food d Drugs, Fertilisers and Feeding Stuffs, Soils and ater—F. N. Appleyard and A. Lees; in the branch of e Chemical Technology of Textile Manufacture— Humphries; in the branch of the Chemical Technology Cement Manufacture—S. Bowman. For the Certificate: the branch of the Chemistry of Food and Drugs, rtilisers and Feeding Stuffs, Soils and Water—S. Dixon, .Sc., A.I.C.

## MEETINGS FOR THE WEEK.

*Monday, May 17.*

oyal Society of Arts, 8. (Cantor Lectures). "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758—1837," by A. T. Bolton.

*Tuesday, May 18.*

oyal Institution, 3. "British Ethnology—The Invaders of England," by Prof. Arthur Keith.

stitution of Petroleum Technologists, 5.30. "Air Lift System of Pumping Oil Wells," by R. Stirling.

*Wednesday, May 19.*

oyal Society of Arts, 4.30. "Electrical Osmosis," by J. S. Highfield.

ciety of Glass Technology, 2. Discussion on "The Physical Properties of Glass."

*Thursday, May 20.*

oyal Society, 4.30. "Some Notes on Krypton and Xenon," by Prof. J. N. Collie. "Experiments on Electron Emission from Hot Bodies," by Sih Ling Ting. "The Aspherical Nucleus Theory applied to the Balmer Series of Hydrogen," by L. Silberstein. "Conditions at the Boundary of a Fluid in Turbulent Motion," by T. E. Stanton, Miss D. Marshall, and Mrs. C. N. Bryant.

oyal Institution, 3. "Welsh and Irish Folk Song," by A. P. Graves.

stitution of Electrical Engineers, 5.30. (Annual General Meeting).

yal Society of Arts, 4.30. (Indian Section). "Roads and Transport in India," by Brig.-Genl. Lord Montagu of Beaulieu.

emical Society, 8.

*Friday, May 21.*

oyal Institution, 9. "The Thermionic Valve in Wireless Telegraphy and Telephony," by Prof. J. A. Fleming.

*Saturday, May 22.*

yal Institution, 3. "The Re-action and the Critics of the Positivist School of Thought," by Frederic Harrison.

## NOTES AND QUERIES.

hosphides of Sodium.—Could any reader say if phosphides of ium have been described, and where?—ERIC TOMLINSON.

THE
CHEMICAL SOCIETY RESEARCH FUND.

A meeting of the Research Fund Committee will be held in JUNE next. Applications for Grants, to be made on forms which can be obtained from the Assistant Secretary, Chemical Society, Burlington House, London, W. 1, must be received on or before TUESDAY, JUNE 1, 1920.

All persons who received Grants in June, 1919, or in June of any previous year, whose accounts have not been declared closed by the Council, are reminded that Reports must be returned by Tuesday June 1, 1920.

S. E. CARR, Assistant Secretary.

MANCHESTER MUNICIPAL
COLLEGE OF TECHNOLOGY
(UNIVERSITY OF MANCHESTER)

Students desiring to enter upon one of the courses leading to the degree of Bachelor of Technical Science in the University of Manchester or to the University Certificate in Technology for the first time at the beginning of the Session 1920 1921 should apply not later than 20th May to the Registrar, College of Technology, from whom forms of application may be obtained. A first selection of applicants will then be made.

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Detailed particulars, Permit to View, and Tender Forms can be obned on application to Controller, D.B. 1 E., Plant and Machinery ction, Charing Cross Huts, Embankment, W.C. 2.

Tenders to be returned not later than 10 a m. on Saturday, May 29,

NOTE.—For particulars of other Government Property for le see "SURPLUS," price 3d. at all bookstalls, or by arterly subscription of 2/- post free, payable in advance to e Director of Publicity, Ministry of Munitions Whitehall ace, London, S.W. 1.

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# NOTICES.

EDITORIAL.—All Literary communications, and Books, Chemi[cal] Apparatus, &c., for review or notice to be addressed to [the] Editor.

SUBSCRIPTIONS, £1 per annum, payable in advance, should [be] addressed to the Manager.

BACK NUMBERS and VOLUMES can be purchased on applicat[ion t]o the Manager.

ACCOUNTS for Advertisements up to March 31 should be paid to Manager.

THE CHEMICAL NEWS,
16, Newcastle Street, Farringdon Street,
London, E.C. 4.

## ADVERTISEMENTS.

All communications for this Department should be [ad]dressed to—
T. G. SCOTT & SON,
63, Ludgate Hill, London, E.C. 4.


Wanted for the Library at the Ardeer Facto[ry] of Nobel's Explosives Co., Ltd., a well qualified Chem[ist] having thorough knowledge of French and German.—Applicatio[ns] accompanied by details of experience, qualifications, &c , should [be] sent to The Manager, Research Section, Ardeer Factory, Stevenst[on]

Metallurgical Chemist, University trainin[g] open for Engagement. Thirteen years' experience in [la]r[ge] Steelworks Laboratory in Sheffield. Could take control of laborato[ry]. Excellent references.—Address, Box 778, Scott and Son, 63, Ludg[ate] Hill, London, E.C. 4.

Ex-Soldier (22), Inter. Sci. Chem., knowled[ge] of Metallurgy and Assaying, seeks Position in Laboratory. Address, Box 781, Scott and Son, 63, Ludgate Hill, London, E.C. 4

Metallurgical Chemist (22), Energetic, e[x-] service, experience in Analysis of Iron and Steel, Ores, Sla[gs,] Refractory Materials, &c., requires Situation. Manchester distr[ict] preferred.—Address, Box 782, Scott and Son, 63, Ludgate Hill, L[on]don. E.C. 4.

Assistant Chemist wanted by large Manufa[c]turing Firm in S.W. London, with Analytical experience up [to] the standard of the Intermediate Institute of Chemistry. State a[ge,] training, experience, and salary required.—Address, Box 787, Sc[ott] and Son, 63, Ludgate Hill, London, E.C. 4.

ASSISTANT CHEMISTS wanted at on[ce] for the Admiralty Inspection Laboratories at Holton Hea[th.] Candidates must have a qualification equivalent to that of the As[so]ciateship of the Institute of Chemistry, and must possess a sou[nd] knowledge of Technical Analysis, preferably of explosives.
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Applications, stating qualifications and experience, should be ma[de] by letter to the Inspector of Naval Ordnance, Holton Heath, ne[ar] Wareham, Dorset.

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Applications are invited for the Post [of] CHIEF LECTURER IN CHEMISTRY. The duties co[m]mencing September next.
Consideration will be given to applicants who, in addition to University Degree, have had special training and experience in Indu[s]trial Chemistry.
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A schedule of duties may be obtained from the Director of Edu[ca]tion, Education Offices, 14, Sir Thomas Street, Liverpool, and app[li]cations should be received by him not later than May 24.
E. R. PICKMERE,
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CHEMICAL NEWS
Vol. CXX., No. 3136.

EGATION AT THE MELTING POINT.

WILLIAM R. FIELDING, M.A., M.Sc. (Vict.),
Science Master at King Edward VII. School, Lytham.

ollowing conclusions have been obtained as the thousands of calculations, carried on inter- during the last three years, it is impossible to sequence in which the work proceeded. The ons have been revised from time to time and not claimed even yet.

long been believed that the differences between quids, and gases are due to differences in their r aggregations. Molecules, like human beings, ve to themselves; and while at high temperatures be compelled to pursue solitary and individualistic they readily return to their former states of aggre- nder suitable conditions of temperature and pres- Sometimes we may have two solid substances ly mixed without chemical action ensuing; but e disintegrating effects of heat both solids are , and then gasified, with the result that new inter- ons are brought about, or chemical action takes While certain conclusions have been reached with o the degree of association amongst compounds, sent paper is confined mainly to the complex tions which exist amongst elements at their melting These conclusions have only been possible as the the patience and skill with which other investi- ave determined physical constants, and it is hoped present work will likewise prove a stepping stone r things.

are certain regularities in the properties of similar s and compounds, and frequent attempts have been generalise the series. For instance, amongst the s there is—

n increase in the melting point and boiling point vith increase in molecular weight.

n increase in the specific gravity with increase in e molecular weight.

ngst the halogens there is an increase in the melting oiling point, and density, &c., with an increase tomic weight (Table I.).

TABLE I.

| | Atomic weight. | M.p. | B.p. | Density. |
|---|---|---|---|---|
| .. | 19 | 50° | 86° | 1·14 (liquid) |
| .. | 35·5 | 171° | 239·4° | 1·44 " |
| .. | 80 | 266° | 331·7° | 3·19 " |
| .. | 127 | 387° | 458·5° | 4 95 (solid) |

melting point is neither directly proportional to, ersely proportional to, the atomic weight; nor is it proportional to, nor inversely proportional to, the root of the atomic weight.

d every expedient to discover the relationship melting point and molecular weight and ulti- arrived at the following hypothesis, for which, I there is ample substantiation.

. the melting point the molecules (or atoms) of each are aggregated in a definite manner to form ules," and the weight of a melticule I called its lar weight. The melticular weights of the elements with melting point; *i.e.*, the melting point is a n of the melticular weight.

2. If we plot melting points against melticular weights all the elements lie on a *single parabolic curve*; and if we choose a number of elements whose melting points are close together the curve is nearly a straight line.

3. A preliminary investigation was first carried out with chlorine, bromine, and iodine. I made the melticular weight of bromine equal to 400 (corresponding to $Br_5$), and the melticular weights of the other elements are relative to this (any other convenient number might have been taken). Bromine and iodine (the two heaviest *elements of the halogen family*) approximate in their physical and chemical properties. I therefore made a further assumption—that *bromine and iodine are equally* aggregated at their melting points, an assumption which proves to be not unjustified; that is, if the bromine melticule is $Br_5$ the iodine melticule will also be $I_5$, and its melticular weight be 635.

4. The melticular weights and melting points of bromine and iodine are related as follows:—

$$\frac{\text{M.p. of bromine} - x}{\sqrt{\text{Melticular weight of bromine}}} = \frac{\text{M.p. of iodine} - x}{\sqrt{\text{Melticular weight of iodine}}} = k.$$

Hence—

$$x = -199{\cdot}5$$

and—

$$k = 23{\cdot}27.$$

If—

$$\frac{\text{M.p.} - x}{\sqrt{\text{Melt. weight}}} = 23{\cdot}27,$$

then—

$$\frac{\text{M.p.} + 199{\cdot}5}{23{\cdot}27} = \sqrt{\text{Melticular weight}}.$$

The absolute melting points of chlorine, cæsium, gallium, &c., which are not very different, were now substituted in this equation, their melticular weights founde and by dividing the latter by their atomic weights, their rates of aggregation (R) at the melting point were calculated. The results appear in Table II.

TABLE II.

| *Element.* | *M.p.* | *Melticular weight.* | *R.* |
|---|---|---|---|
| Cl .. .. .. | 171·5° | 248·5 | 7 |
| Hg .. .. .. | 234·1° | 347 | 1·74 |
| Br .. .. .. | 266° | 400 | 5 |
| Cs .. .. .. | 299° | 459 | 3·45 |
| Ga .. .. .. | 303° | 466 | 6·6 |
| Rb .. .. .. | 311° | 481 | 5·6 |
| P (yellow) .. | 317° | 493 | 16 – |
| K .. .. .. | 335·3° | 528 | 13·5 – |
| Na .. .. .. | 370·5° | 600 | 26 |
| I .. .. .. | 386·7° | 635 | 5 |

The specific heats of the above elements have been determined at temperatures which closely approximate to their melting points; and the next step was to connect the specific heats at the melting points with the melting point and the rate of aggregation (see Table III.

TABLE III.

| Element. | M.p. | Sp. ht. | Temp. of obs. (almost at the m p.). | R. | $\frac{\text{Sp. ht.}}{\text{R.}}$ |
|---|---|---|---|---|---|
| Cs | 299° | 0·04817 | 273° | 3·45 | 0·0139 |
| Ga | 303° | 0·079 | 273° | 6 6 | 0·012 |
| P (*a*) | 317° | 0·202 | 273° | 16 – | 0·0125 |
| K | 335° | 0·1662 | 273° | 13·5 | 0·0123 |
| Na | 370·5 | 0·2934 | 273° | 26 | 0·0113 |
| S | 380° | 0·1884 | (288–370°) | 19·5 | 0·00966 |

(*a*) Yellow.

If we plot $\frac{\text{sp ht.}}{R}$ against m.p. we shall find that all the above elements lie on a parabolic curve, but if we plot (m.p.×*s*) against R the curve is nearly a straight line. For the elements in Table III. the value of—

$$\frac{\text{M.p.} \times s \text{ (at the m.p.)}}{\text{R (at the m.p.)}}$$

is approximately 4·15; *e.g.*, for—

| | |
|---|---|
| Hg .. .. .. .. .. | 4·29 |
| Br .. .. .. .. .. | 4·13 |
| Cs .. .. .. .. .. | 4·16 |
| P .. .. .. .. .. | 4 |
| K .. .. .. .. .. | 4·13 |
| Na .. .. .. .. .. | 4·18 |
| I .. .. .. .. .. | 4·18 |

It seems probable that if the specific heat of an element could be accurately determined at the melting point, the value of R (relative to $Br_5$) could be readily calculated from—

$$\frac{\text{M.p.} \times s}{R} = 4{\cdot}15.$$

The product of atomic weight and R is the melticular weight, and, as has been pointed out already, if melticular weights are plotted against m.p. all the elements will lie on a single parabolic curve. As the values of *s* (at the m.p.) are only available for a few elements the curve has been built up in five sections.

1. From 2 — 171·5°.
2. From 171·5— 387°.
3. From 387 — 932°.
4. From 932 —1725°.
5. From 1725 —3875°.

All temperatures are on the absolute scale. The results for the second section of the curve are given in Table IV.

TABLE IV.

| Element. | M p. | Melt. wt. | R | *s* (at the m p.) $= \frac{4{\cdot}15 \times R}{\text{m.p}}$. | Calc. at ht. at m p. |
|---|---|---|---|---|---|
| Cl | 171 5° | 248·5 | 7 | 0·169 | 6 |
| Hg | 234·1° | 347 | 1·74 | 0 0307 | 6·14 |
| Br | 266° | 400 | 5 | 0·0776 | 6 2 |
| Cs | 299° | 459 | 3·45 | 0·0476 | 6·33 |
| Ga | 303° | 466 | 6 6 | 0·09 | 6 3 |
| Rb | 311° | 481 | 5·6 | 0 0743 | 6·35 |
| P (*a*) | 317° | 493 | 16 - | 0·2084 | 6 46 |
| K | 335·3° | 528 | 13·5 - | 0·1662 | 6 5 |
| Na | 370·5° | 600 | 26 | 0·2898 | 6 66 |
| I | 386·7° | 635 | 5 | 0 0535 | 6·8 |

(*a*) Yellow.

(To be continued).

CATALOGUES FOR CHILE.—The Commercial Secretary to His Majesty's Legation at Santiago de Chile (Mr. W. F. Vaughan Scott), has written to the Department of Overseas Trade, stating that frequent enquiries are being received by him for the catalogues of United Kingdom manufacturers and that a useful purpose would be served if firms prepared to do business in Chile would forward him duplicate copies of any catalogues issued by them. Catalogues (if possible printed in Spanish) should be addressed by interested British firms direct to the Commercial Secretary, His Britannic Majesty's Legation, Santiago, but this Department would also be glad to be informed, should you decide to take any action in the matter. Parcel postage rates to Chile are as follows:—Not over 3 lbs., 2s.; over 3 lbs. but not over 7 lbs., 3s.; over 7 lbs. but not over 11 lbs., 4s.

## THE ULTIMATE MATTER.

By J. FREDERICK CORRIGAN.

"To search thro' all
And reach the law within the law."
TENNY

FROM the dawn of history Man has speculated a
again on the causes of various effects which
observed during his material existence. He h
himself the question—Why are Things as they a
is their cause; from whence do they come; and
do they go?

Curiosity is an inherent quality of the human m
although it may exist to a modified extent in th
animals, the great curiosity, or the desire for
typically human. It is not an evolutionary produc
ing more and more in intensity as one generation s
another. The philosophers of old were just as
and speculated on the origin and nature of things
as much as we do, and if their methods and the
of their speculations were not always correct, it d
disprove the fact that curiosity is not the resu
evolutionary process, and that their desire for kn
and truth was as great as ours is.

Since his advent on earth, many have been the
problems which have assailed the intruding mind c
To this day, if not *the* "Riddle of the Universe," c
one of the riddles of the universe is—What is
what is it's origin and ultimate fate? What is t
stance, the Thing of which our earth is comp
which we are constantly surrounded, and of whi
our very bodies are composed? Truly a difficult qu
a question which has occupied the speculations
from the remotest ages, and which even now is f
being completely solved.

There is another attribute to the human mind, a
auxiliary sense which acts as a guiding principle i
respects. It is an almost undefinable quality, and
it is referred to as "Intuition." In some individu
intuitive faculty is developed to an appreciable
whilst in many others it is almost non-existent, or
rate is quite dormant during the greater part
existence. It is a quality, useful in many respec
even now, when all our scientific knowledge fail
the trail leading out to discovery seems barred, imp
blocked, we turn to intuition, and more often than
feel the truth or untruth of an apparently una
problem.

From the earliest beginnings, Man seems to hav
tively believed that matter is discrete and not conti
The idea that matter is a solid mass, infinite in all
sions, is hardly conceivable, and so we find the
philosophers turning to the conception of matter p
ing a grained or granular structure.

Long before the advent of the Grecian philosop
Hindus had conceived the idea of the atomic struc
matter, and they had also postulated a certain
between the atoms. Thus, we find Kanáda, one
founders of Hindu philosophy, teaching that:—

(1) Matter is not continuous, but is discrete.
(2) All substances are composed of particles whi
separated from each other by an empty space
(3) The particles have a certain attraction fo
other.

To these postulations, the Greek philosophers add
assumption that the particles are in constant motio
also that they are indestructible and unchangeable.
of Alexandria (177 B.C.) gives expression to these
and referring to the compression of gases, he says:—

"There are void spaces between the particles
just as there is air between particles of sand; wh
air is compressed, the particles are forced into the
spaces, and when the pressure is removed they ret
their former position."

ient philosophy, however, made the mistake of abso- ignoring experiment. *To the ancient philosophers* an extremely undignified and menial act to perform *eriment.* All true knowledge should originate in ind and not be conveyed externally to the mind h the senses. Thus we read of an ancient philo- plucking out his eyes in order that his mind might e distracted by material things, and that all his es might be spent wholly in contemplation.

ether by chance or otherwise, the ancient theory of omic structure of matter proved to contain many of truth, and long before the time of Dalton we iany philosophers leaning towards the atomic theory itter. That the conception was present in the mind Isaac Newton is evinced by his words:—

seems probable to me, that God in the beginning d matter in solid, massy, hard, impenetrable par- of such sizes and figures, and with such other rties, and in such proportions to space, as most con- to the end for which he formed them; and that primitive particles, being solids, are incomparably r than any porous body compounded of them, even *ry hard as never to wear or break in pieces;* no ary power being able to divide what God Himself one in the first creation."

:on, Descartes, Hook, Mayow, and Boyle all more s shared these views, but it was left to John Dalton tangle these confused threads of thought and so to the famous theory which bears his name.

*Early Ideas Regarding the Elements.*

e idea that matter can be traced back to one ultimate indamental substance appears to have haunted uman mind throughout the ages. Men have again ively felt that an elemental form of matter exists or xisted, and that *all the different atoms* or elements merely formed by different aggregations of this mate matter."

t us turn for a short time to the early ideas and con ons of the elements, and see if this "ultimate matter" may not be detected running continuously throughout iuman mind, and now and then cropping up on the .ce here and there.

ie "elements" of the Greek philosophers may be idered to signify *principles* rather than elements in ense which we understand the term. Even here, the 'mate matter" conception is at work, for especially ngst the early Greek philosophers there was a great ency to postulate one element or principle as funda- tal, and to evolve all the other elements and their pounds from it.

hales of Miletus, who lived and flourished in the ) century B C., taught that water was the first principle natter. This assumption, however, could not be sed to have originated in Thales, *for on referring to* i remoter periods in history we find the conception of er as the first principle of all things still evident. iough other theories were advanced from time to time, conception of Thales lasted throughout twenty-four :uries, and was only finally disrupted by Lavoisier 'o) in his classical experiments in which he showed the *ossibility of* converting water into earth.

.nother conception of a primary substance may have its origin in the fire- and sun-worshippers, but it was until the time of Heracleitos (460 B.C.) that fire was ociated with the principle of matter. Heracleitos, 'ever, assumed that air, water, and earth are each ned by the successive condensation of fire. Moreover, belans *affirmed that air when rarefied becomes fire,* when condensed is converted into water. It is thus y to understand how prevalent the idea was amongst medieval alchemists, that when water is boiled it omes converted into air.

'herecedes supposed earth to be the ultimate principle the universe, but it was left to Empedocles to introduce the idea of the existence of four distinct elements, viz:—

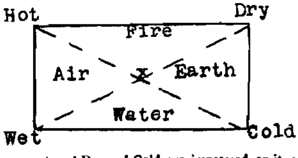
| | |
|---|---|
| Fire. | Water. |
| Air. | Earth. |

These, Empedocles asserted, whilst not being capable of being *converted into one another, formed all things by* their combination. His experiment in support of this view appears rather baneful in the light of modern con- ceptions. Wood is burnt on a slate, water or moisture is deposited on the cooler portions of the slab, fire and air (smoke) are given off, whilst ashes (earth) remain. Hence wood is composed of the four elements—Fire, Air, Water, and Earth.

On the other hand, however, Anaxagoras, about the year 500 B C., may be found putting forward a view which approximates more than any other to our modern concep- tions of the elements. According to Anaxagoras, in the Beginning all things existed in extreme disorder. At the creation, these mingled particles of matter, existing in infinite chaos, were combined and arranged in definite order by a ruling intelligence. The primary particles of matter were not definite elements like those of Empedocles, but they were called by Anaxagoras "homoeomeries." These homoeomeries, it is to be assumed, were exactly *alike in every respect, and it was only by the aggregation* of these small particles that matter *en masse* was formed. Thus a lump of gold was the result of the aggregation of myriads of homoeomeries; silver was produced when a different number of homoeomeries associated themselves together, and so on with all the other material things of the universe.

*Leucippos and Democritus also taught the same theory,* more or less modified to suit their personal ideas, and thus the same "ultimate matter" idea is seen coming up to the surface of men's minds and greatly influencing their conceptions.

Amongst the ancients, the most voluminous writer on the Natural Sciences was Aristotle (385 322 B C.), and it *is no wonder that the speculations* and theories of Anaxagoras, Leucippos, and others were more than over- shadowed by his more brilliant personality and status in the domain of science. Aristotle wrote numerous volumes and treatises on the Heavens, on Generation and Corrup- tion, on Physics, on Respiration, &c., &c., and *his views* both on science and metaphysics were almost universally *accepted by the alchemists of the middle ages,* and some of them have survived even to the present day. Aristotle accepted the four element theory, but to these four elements, or essences of things, he added a fifth in the shape of the Ether (afterwards called the *quinta essentia* or *quintessence*) which was infinitely more *subtle and intra-* penetrable than the other elements. Unlike Empedocles, he asserted that the four elements *are* mutually convert- ible into each other, and to each element he assigned two qualities, one of which was possessed by one of the other three elements. The primary matter to the Aristotelians was a πρώτη ὕλη or "first matter." When two principles *were impressed on the primary matter it took the form of* one of the elements,—Fire, Air, Water, or Earth. Thus, diagrammatically, if $x$ represents the primary matter, if




the properties of Dry and Cold are impressed on it, earth is produced, whereas if the properties Dry and Hot are given to it, the result is fire.

*The "Tria Prima"—Transmutation.*

As has already been stated, the idea of experimental work was repulsive for the Greek School of thought, and no self-respecting Greek philosopher would ever dream of debasing himself in this manner. The Egyptians, however, whilst not being profound theorists like the Greeks, were rapidly developing the practical side of alchemy, and it is to them that we owe the foundations of many of our chemical processes, especially the metallurgical art. In time, however, the Greek philosophers began to visit Alexandria, and no doubt they often brought there, and gave vent to their ideas. It is in the mingling of Grecian and Egyptian ideas that the beginnings of chemistry stand, and out of their conceptions the doctrine of the "Tria Prima" arose, with its subsequent re-awakening of the desire to change base metals into gold.

The doctrine of the "Tria Prima" is found best expressed in the works of Geber—or as his complete title is said to be, *Abu-Moussah-Deschabir-Al-Sufi*—an Arabian alchemist who lived in the eighth century. Geber, whilst apparently not bothering with the primordial matter of the Greeks, regarded all matter as being composed of three primary elements—Mercury, Sulphur, and Salt. Metals he especially considered to be compounds in different proportions of Mercury and Sulphur. The "soul" of mercury was responsible for all the lustre and metallic properties of the metal, whilst the "soul" of the sulphur was regarded as being associated with the combustibility of the metal. Sulphur was also an impurity which detracted from the value of the metal, and thus the noble metals were considered to be made up of the maximum quantity of mercury combined with the minimum of sulphur. Salt was the element which gave to substances their "earthy" properties, the "salts" of the alchemists of Geber's time being all unchanged by heat.

The theory of Tria Prima had considerable life, and even in the year 1735 we find one George von Welling, an alchemist of Hamburg, expressing his ideas as follows:—

"That the universal mercury, which is also salt sulphur, is to be found in all things even in the minutest atoms, and in the spirit and upholder of all things; must not be unknown to those who are versed in the true art of separating. When this mercury is suspended from any body there remains only a gross selfish sulphur, which is without life."

It is not to be wondered at that these ideas strengthened in the minds of men the desire to transmutate metals, and to convert the base metals into the noble ones. The transmutation of base metals into gold was the great aim of every true alchemist, and the desire has been traced back to a certain Hermes Trismegistus and his "Emeraldine Table," which contained thirteen sentences referring to the mystic art of making gold. Hermes Trismegistus, however, is too much surrounded by the mists of antiquity for us to form any opinions of his ideas, and more probably than not, his Emeraldine table and the works ascribed to him are the products of imaginative mediæval copyists.

*The Theories of Paracelsus regarding the nature of Metals.*

Paracelsus, or to give him his full but unwieldly name—Philippus Aureolus Theophrastus Paracelsus Bombastus von Hohenheim, although he is described as "a man of violent passions, coarse, drunken, arrogant, and unscrupulous," put forward ideas which remained and influenced much of the later alchemical work. Although Paracelsus believed that mercury, sulphur, and salt entered into the composition of all things, material and even immaterial, it is to him that the honour belongs of gathering together the ends of old suggestions and ideas which gave to the metals the property of being *generated in the* earth, much in the same manner as animals are generated on the surface of the earth—and of uniting them together in the form of a quasi sexual theory.

According to this doctrine, sex properties
buted to all substances—metals in particula
some mysterious process of union between t
new metals were in time produced within the
the earth. All the metals possessed a sort
fluid or fecundating substance, on which the
properties depended. The great and grand
the alchemist was to discover this fecundating
and by its use to prepare that most perfect of a
gold.

Here is seen the fundamental conceptio
"Philosopher's stone," that all-comprehensive
descriptions of which alchemical literature simp
with. Every alchemist described it, and ma
that they had actually seen and touched it. Tl
pher's stone is spoken of by many alchemis
"Universal spirit," the "grand Magistrium
quintessence," and evidently it was the substanc
all matter was composed—in fact our "ultimat
again.

*Modern Conceptions regarding the Unitary T of Matter.*

These doctrines, which the alchemists regarde
almost sacred, had their time, lived their life, a
like many other theories, they died a rather
death after receiving many fatal blows from the
those who were developing a scientific chemistry,
were ridding the study of the natural phenomena
habitual environment of secrecy and mystery.

One of the first of these men who discredi
of the quaint and weird ideas of the alchen
Robert Boyle (1627-1691). His works slowly b
overthrew the doctrine of the Tria Prima,
Paracelsian dogmas, and he was probably the fir
shadow our present system of elements. Boy
member of "The Invisible College," a small banc
lectuals who met together on occasions "to disc
consider of philosophical inquiries and such a
thereunto." The Invisible College proved t
nucleus of a great scientific association, and eve
blossomed forth into the Royal Institution, an
of philosophers which attracted men from all
world, and which performed the greatest service i
out the scientific fragments from the lurid
alchemical literature, and by putting them togeth
bit, thus in time forming a coherent chain of thou

(To be continued).

## THE THEORY AND PRACTICE OF LUBRIC THE "GERM" PROCESS.*

By HENRY M. WELLS and JAMES E. SOUTHCOM

THE considerations which we wish to bring forwa
paper are the results of many years' experience
problems of lubricating oil and lubrication, studie
physical and physico-chemical standpoint, assiste
intimate and daily contact with the lubrication of
of machinery and prime movers. Our primary ob
to elucidate the reason for the obviously superior lu
efficiency of fatty glycerides over "straight" min
in a large number of practical cases which had
our notice.

As a corollary to this we had to review the
principles upon which lubrication depends and to
explanation of the peculiar property which has bee
"oiliness," "body," &c., by authorities in the pas

It may not be out of place here to review the
of our knowledge of lubricants and lubrication.

*From the *Journal of the Society of Chemical Industry*,
1920.

isor C. V. Boys, in his Presidential address to the l Society in 1908, crystallised the position very in these words:—

*vas found that the lubricating property of oil* :d on something which at present is unknown—It scosity—animal and vegetable oils lubricate better, ey are more "slippery" than mineral oils of the scosity, and though the oil trade has known how to ood 'slippery' mixtures, no one at present knows oiliness' is, and this is at the present time an ut *physical quest of the engineer.*"

a, Professor J. S. Brame (*J. Inst. Pet. Tech.*, 1918, ) has said that "the property of 'oiliness' was one nost puzzling of the properties of oils. By some it garded as unnecessary to connect it with viscosity , since it was possessed in a much greater degree e fixed oils than by many mineral oils which had ally the same viscosity."

necessary to distinguish clearly between two dis*asses of lubricating practice. On the one hand we* he lubrication of fast-moving shafts, &c., supplied large excess of oil frequently under pressure, and in ase the frictional values are dependent primarily the viscosity of the oil; the mathematical and mental investigation of these cases have been amply l by Reynolds, Tower, Lasche, and others. On the *and we have to deal with slow speeds at high bear*ssures, frequently with a very limited supply of oil, is in these cases that the special property of "oilior "body" is requisite to maintain the film, and it : that viscosity measurements no longer assist us in oice of the lubricant.

s view received unanimous support at the recent disn on lubrication at the Physical Society.

at are the possible physical properties of a liquid *influence its character as a lubricant?* They are ity, density, capillarity or surface tension, combility, and tensile strength. It is true that very work has been done on compressibility and tensile th, but from the observations of Worthington and i it would appear doubtful whether they would play a *guishing* rôle in the differentiation of oils; and, r, as we shall point out, there is what appears to us equate explanation of the nature of oiliness without g upon these properties.

far as density is concerned there exists a wide range roleum mineral oils possessing specific gravities idenwith those of the fatty or fixed oils, hence it is clear density plays no determining part. Viscosity is, of e, of great significance in the cases of high speed, &c., eferred to.

w *it remained for Ubbelohde to point out* that only id which "wets" or "spreads over" the solid can itute a true lubricant, because in order for the liquid ce itself into the narrower spaces of higher pressure essential on capillary grounds that the said liquid "wet" the solid surfaces.

nsider the case of two eccentric glass surfaces which *eing forced together with a drop of mercury or oil* een them. Now since the mercury (fig. 1) does not " or spread over the glass, the meniscus in this case e convex to the liquid, while in the case of the oil 2), which wets the surfaces, the meniscus will be con. In the case of fig. 1 (mercury) the tendency on lary grounds will be for the liquid to gather itself up a drop and to pull the liquid film in the direction of ray from the narrower constricted area of greater *ure at b. In the case of oil (fig. 2.) the opposite will* e case. The oil will, owing to its meniscus, tend to olled towards *b*, or, in other words, will force itself the narrow spaces.

is is exactly what is required in a lubricant, namely, it shall penetrate into the narrow spaces between al and bearing, and from the above considerations *clearly sees that liquids which do not "wet" solid* ces cannot be described as lubricants.

Only those liquids which "wet" a solid surface possess lubricating power in the generally accepted sense.

Although these considerations appeared to indicate the *connection between lubrication and capillarity, it will be* seen that they only go so far as to enable us to say that *mercury is not a lubricant and that oil is a lubricant. This* is a conclusion of considerable theoretical interest, but it is not very helpful to the oil technologist who desires to differentiate between different classes of oils.

Accordingly we find that these speculations of Ubbelohde *led to no practical result.*

On the other hand, certain theoretical considerations had *led to the conclusion that the permanence of liquid* films depended upon capillary relationships, and in particular that *pure liquids would not form stable films.*

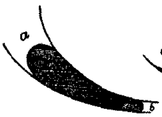



FIG. 1

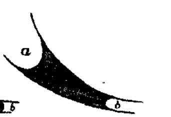
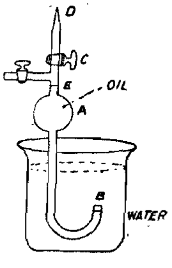



FIG. 2.

*These principles had not been applied, however, to the* problem of lubrication, and, in fact, they were directly contradicted by prevailing practice in which there was a constant tendency towards greater purity, *i.e.*, in the direction of refining the mineral oils which were used, and in the direction of using acid-free oil as a compounding ingredient.

The *generally accepted view was therefore that capil*larity was not a deciding factor in connection with the phenomenon of "oiliness," and various standard works contain statements to this effect.

It was under these conditions that we began our experiments. We were at once met by the fact that it was not possible to measure the surface tension between oil and the solid metal bearing, and *it is probably on this account* that Ubbelohde's speculations remained abortive. The




usual "surface tension" is that of oil against air, and we confirmed the results of *previous* investigators, viz., that the results so obtained, for instance, by observing the rise in a capillary tube, shed no light at all on the question under consideration.

At this point we decided to measure the surface tension *of the oil against an immiscible liquid in the hope that this* might furnish some criterion of "oiliness." On *proceeding to measure* this interfacial tension, *i.e.*, the surface tension between oil and water, startling results were at

once obtained. The method of experiment was by the drop pipette as follows:—The pipette consists of a U-shaped capillary tube provided with a bulb A and a ground glass orifice B. The bulb A is filled with oil to the mark E. By means of the capillary D a very slow flow of oil may be obtained at B by opening the stopcock C. The orifice is immersed in a beaker of water, and the number of drops formed by the given volume of oil in A is counted. The surface tension oil-water is inversely proportional to the number of drops (Donnan, *Zeit. f. Physik. Chem.*, vol. xxxi., &c.).

A series of mineral oils were tested with this instrument, and then a series of animal and vegetable oils, and compounded oils.

(To be continued)

## STUDY ON THE REACTIONS IN THE METALLURGY OF ZINC.

Reduction of zinc oxide, as is now admitted, does not take place directly, but through the agency of the carbonic oxide formed either in the initial stage of the operation or owing to oxidation of the carbon by oxygen of the air in contact.

$$ZnO + C = Zn + CO \quad (1)$$
$$ZnO + CO = Zn + CO_2 \quad (2)$$

The carbonic anhydride produced is reduced by the excess of carbon in the mixture. The reaction (2) is considered to take place at a very high temperature. The initial temperatures of the reaction (points of reaction) vary from 900° to 1150° C. according to different authors.

To verify these various points M. Lemarchands examined—

1. The possibility of a direct action of zinc oxide on carbon in an atmosphere of pure nitrogen.
2. The reaction point of the system (ZnO+C), taking as an indicator of the commencement of the reaction the variation of volume which it determines.

From the results obtained it is possible to conclude—

1. That the zinc oxide is directly reduced by the carbon without carbonic oxide, since the reaction takes place in pure nitrogen.
2. That the quantity of carbon brought into play is something between these required for the two possible reactions—

$$ZnO = Zn + CO$$
$$2ZnO = 2Zn + CO_2$$

It must then be admitted—

(*a*) If we accept the theory, as has hitherto been done, that part of the zinc oxide escapes reduction; and

(*b*) If we do not do so, that reduction of the zinc oxide by carbonic oxide takes place with a greater speed than than that of reduction of carbonic anhydride by carbon.—*Comptes Rendus*, March 29, 1920.

## POTASH FROM KELP.

In the *Journal of Industrial and Engineering Chemistry*, 1919, xi., 864, Messrs. J. W. Turrentine and Paul S. Shoaff describe the experimental plant of the U.S. Department of Agriculture at Summerland, California.

Kelp is collected by boats of 100 to 150 tons capacity, provided with twin screws and driven by internal combustion engines. The extreme bow of the boat is provided with the harvesting apparatus, the kelp is cut by means of knives approximately four feet below the surface of the water, and is then carried to the deck by a conveyor, from 25 to 50 tons are harvested in an hour. The cargo is removed from the boat by an automatic fork which delivers its load to the hopper of a chopper on The chopper cuts the kelp into lengths of appr 6 feet, which are then moved to the storage b plant by drag conveyors. The raw kelp is f rotary drying kiln, where it meets a counter curr air, which enters the kiln at a temperature of 80 leaves it at a temperature of 50° C. This pr drying is followed by a final drying in a similar k dried kelp is fed into the top of a retort, which is temperature of approximately 980° C. The char is drawn off from a hopper at the bottom of cooled, ground, and lixiviated. The by-prod recovered.

In the lixiviation use is made of leaching troug presses, and the principle of the counter curre char is first extracted with a concentrated brin fresh hot water is used for its final extraction. T coke of charcoal is extracted successively with ho chloric acid and water, by proper extraction, a pr obtained which is of value as a decolorising a certain organic liquids and aqueous solutions. T coal is then collected in a filter press and dried.

After removal of sulphates, the brine from the l process is heated in a vacuum pan until a definite tration is reached, it is then transferred to a crystalliser, where the potassium chloride deposit cooled brine is returned to the vacuum pan and concentrated while sodium chloride separates. E is washed, dried first in a centrifugal machine, th rotary, counter-current, hot-air drier, and finally for market. The mother liquors are used until th tent of iodine salts has become sufficiently great are then treated for the recovery of iodine as a by-

The volatile by-products recovered from retor clude ammonia liquor, methyl alcohol, and an oil late from which have been obtained an oil whic value in the concentration of ores by flotation, creosote which is highly toxic to bacteria and may as a wood preservative. Gas is also produced retort and is used as fuel.

By another process, the dried kelp is fed into c of a rotary kiln while a flame from burning oil enter other end; the kiln is lined with fire brick. Cha produced and leaves the kiln at a low red heat; it quenched, ground, and leached to obtain the potas or it may be permitted to burn to a loose, gre caking kelp ash with a potassium content equal to a mately 35 per cent $K_2O$.—*Journal of the Fr Institute*, clxxxviii., No. 6.

# PROCEEDINGS OF SOCIETIES.

## ROYAL SOCIETY.

*Ordinary Meeting, May 6, 1920.*

Sir J. J. Thomson, O.M., President, in the Cha

The following papers were read:—

"*The Aerodynamics of a Spinning Shell.*" By , Fowler, E. C. Gallop, C. N. H. Lock, and F Richmond, F.R.S.

This paper deals with the motion through a ga body with an axis of symmetry and a spin about tha The range of velocities includes the velocity of sou the gas. It has special reference to the motion ordinary shell through air under gravity. The probl approached from the aerodynamical standpoint. force system imposed by the gas is analysed into its important constituents, by help of the theory of dimen and by detailed wind-channel experiments. The ge equations of motion are obtained in a vector notation

l to tractable approximate forms in certain im- special cases: in particular, when the axis of try and the direction of motion of the centre of nearly coincide. An approximate formal solu- these last equations is obtained, and the errors equations themselves and their solutions shown to ligible.

solutions obtained are submitted to the test of ex- nt, and the magnitude of the more important rs of the force system determined numerically as ons of the velocity of the shell up to twice the y of sound. At the same time, the main assump- nade in the analysis are verified.

experimental method used is to fire shell through a of cards. The shape of the holes left in the cards ines accurately the angular motion of the axis of ell. From this the values of the chief components force system are deduced. One of the principal is to determine accurately the spin required to the shell stable at any velocity. The behaviour of rce components as functions of the velocity appears of scientific interest, and of obvious importance in ical ballistics.

"...esearches on the Elastic Properties and the Plastic sion of Metals." By Prof. W. E. Dalby, F.R.S.

s paper relates to a new type of load extension im recorded automatically by an adaptation of an ment already described to the Society.

e extension of the test piece is multiplied 150 times instrument. With this magnification, about 3/100 sion is shown on the negative, and the elastic line is at a slope of about 60°. The shape of the elastic an therefore be studied, and the process of extension be watched, so that stretching can be stopped at an ned value and the load removed and then re-applied. removal and re-application of the load produces a on the diagram, and several such loops can be ibed on each negative. Looped diagrams taken from ls commonly used are shown. Comparison of these d diagrams show that each metal is characterised by lastic line and loops. A succession of plates was from a test piece of high carbon steel stretched st to breaking.

ese plates set end to end give a procession of loops, show that the loop area tends to a maximum. The ion of time interval between the taking of loops and treatment between the taking of loops are examined lation to loop area. It is shown that in the high on steel and alloy steel, lapse of time has little or no t in restoring elasticity nor is the elasticity restored by ng in water.

w data relating to the strength of material are given ese diagrams, viz.:—

The area of the loop.
The rate of increase of the area of the loop.
The maximum area.

is suggested that these loop diagrams, together with liagrams described in my earlier papers, co-ordinate y of the results of the usually applied tests.

"Investigations on Lightning Discharges and on the tric Field of Thunderstorms." By C. T. R. Wilson, S.

he investigations were carried out at the Solar Physics ervatory, Cambridge, by methods already described ceedings, 1916). Apparatus has been added to secure hotographic record of the readings of the capillary trometer used in the measurements. Changes in the tric field which occupy less than a tenth of a second recorded.

he sudden changes produced in the potential gradient he passage of lightning discharges recorded in 1917 positive in 432 cases; negative in 279.

he mean value of the electric moment 2QH (Q being quantity discharged and H the vertical height through which this discharge is displaced) of a lightning discharge is about $3 \times 10^{16}$ e.s.u. × cms. or 100 coulomb-kilometres.

The mean quantity discharged is of the order of 20 coulombs.

The magnitude of the potentials attained in thunder-clouds is of the order of $10^9$ volts.

The rate of vertical separation of charges in a thunder-cloud may amount to some coulombs per second; *i.e.*, the vertical current through the cloud is of the order of some ampères.

A thunder-cloud or shower-cloud may be regarded as an electric generator, capable of maintaining between its poles an electro-motive force of the order of $10^9$ volts. It tends to maintain an electric current from the earth to the conducting layers of the upper atmosphere, or in the reverse direction, according as its polarity is + or −.

The difference which must exist in the conductivity of the air above shower-clouds of + and of − polarity respectively, owing to the large difference between the mobilities of the negative and positive ions dragged out of the conducting layer by the field of the cloud, furnishes a possible explanation of the normal positive potential gradient at a distance from shower-clouds. It is also shown that it will account for the prevailing negative sign of the potential gradients associated with shower-clouds, and for the preponderance of positively charged rain and positive lightning discharges; *i.e.*, discharges which produce a positive change of potential gradient.

"*The Supply of Energy to Atmospheric Eddies.*" By L. F. Richardson.

Osborne Reynolds investigated the energy of eddies as a balance between income and expenditure. The income was the activity of the eddy-stresses upon the corresponding rates of mean strain; the expenditure was by way of molecular viscosity. His theory refers to an incompressible liquid, but it is shown in the present paper that the same applies to an elastic fluid. In a gravitating atmosphere there is an additional channel for gain or loss, because the eddies act as thermodynamic engines, either producing or decreasing inequalities of temperature. They are, however, imperfect engines. It is shown that the activity contributed by the eddies by this process is—

$$\frac{g}{\gamma p} \; c \; \frac{\delta \sigma}{\delta h} \text{ per volume,}$$

where $g$ is the acceleration of gravity, $\gamma p$ the thermal capacity per mass, $c$ the eddy-conductivity, $\sigma$ the entropy per mass, and $h$ the height. In the actual atmosphere this activity is ordinarily an expenditure by the eddies. By balancing it against their income a criterion of turbulence is obtained. Some observations of the quiescence of wind on a clear evening tend to confirm the theory.

Some analogies between eddy-motion and heat are discussed, and the diffusion of eddies is touched upon.

## ROYAL SOCIETY CONVERSAZIONE.

The Conversazione of the Royal Society was held on May 12, and was very successful. The following are a few items from a very full programme:—

Dr. J. C. Mottram and Dr. E. A. Cockayne. Demonstration of Fluorescence in Lepidoptera by Ultra-violet Radiation.

The beam of ultra-violet rays is produced by means of a quartz mercury vapour lamp in a box with a window of the glass invented by Prof. Wood. This is transparent to radiation of wave-lengths lying between 3900 and 3100 A.V., but opaque to light. Only a small proportion of the Lepidoptera examined have proved to be fluorescent, and all of these are whitish or yellow in colour. The most brilliant are Geometrid moths of the genus Ourapteryx and allied genera. Fluorescent species occur

in other Geometrid genera, in Uraniidæ and Hepialidæ, and in butterflies in the genus Troides. Yellow solutions with a green fluorescence, visible by daylight, have been made by dissolving the wings of Opisthograptis and Troides in glacial acetic acid.

Mr. C. V. Boys, F.R.S.

1. Noon Reflector.—The noon reflector is a very simple form of transit instrument intended to be set on a window sill facing South, and producing a pin hole reflected image of the sun on the ceiling or opposite wall from which the time may be obtained with an accuracy of about one second.

2. Azimuth Declination Time Chart.—The azimuth declination time chart is a graphic representation of the hour angle of the sun for all declinations at a particular latitude, and azimuth from which the hour angle may be read with an accuracy of 1/10 second of time. This is for use with the noon reflector when set at some azimuth other than South. The chart includes a graphical construction for Bessel's interpolation formula.

Major G. W. C. Kaye. Some Recent Applications of the X-rays.

A collection of radiographs illustrating some recent developments of the X-rays, including among others Heilbron's radiographs of paintings by old masters.

Mr. E. A. Reeves. Apparatus for showing the existence of a True North and South Directive Force in the Electricity of the Atmosphere.

This apparatus consists of a large glass bottle with an indiarubber stopper, from which is suspended by a fibre of unspun silk, a gold-leaf paper indicator. The inner side of the stopper is covered with paraffin-wax, and the bottle is coated inside and out with shellac varnish. The whole is mounted on a tripod stand. On a calm clear day, when the apparatus is set up in a high open space, and screened from the direct rays of the sun, it will be found that, after the paper is electrified by touching it with vulcanite rubbed on dry cloth, and left for some time, it will oscillate about evenly on either side of the true North and South line, or come to rest approximately in that direction.

The Osmosis Company, Ltd. Clays treated by Electro-osmosis: Photomicrographs and specimens of articles made with Osmosed Clay.

The phenomena of electrical osmosis, whereby matter in a very finely-divided state is capable of being influenced by an electrical potential, has an important practical use in the purification of clays. The equipment necessary for the process of obtaining osmosed clay consist of a plunger, settling tanks, and osmosis machine, composed of a rectangular trough in which is arranged horizontally a cylindrical metal anode, surrounded beneath the surface of the slip and at a short distance away from it by a laminated cathode, through which the clay slip is driven by paddles. The cylinder revolves slowly, and the dried purified clay is collected by means of a scraper. Low grade and discoloured china clays become usable as paper clays and pottery clays, and all china clays are improved in colour as a result of treatment. The fire clays are rendered more plastic and refractory, and consequently hard bricks can be obtained at a lower baking temperature with saving of fuel. Saggars made from low grade osmosed marls have a life two to three times longer than those made with the raw clay, and, owing to the removal of pyrites, pitting is entirely prevented. Photomicrographs of raw and purified clays are exhibited as well as crucibles and other refractory apparatus.

The National Physical Laboratory. Oriented Lustre of Etched Crystalline Surfaces.

The etched crystalline surface of metal is covered with a number of minute plane facets whose orientation is uniform throughout each individual crystal, but varies from one crystal to the next. A beam of obliq falling on such a surface is selectively reflected facets in such a way that the area of certain appears uniformly and brightly illuminated, whi crystals remain dark. By illuminating such a su means of three separate beams of coloured light upon the crystals at various angles of incidence a effect is produced. Each crystal reflects into the the observer a portion of one of the beams falling at a suitable angle, and the various crystals conse appear of different colours.

Mr. Herbert Bolton. Enlarged Photogra Fossil Insects from the British Coal Measures.

The first recorded fossil palæozoic insect fr country was discovered in the Coal Measures o brookdale in the early part of last century. In 19c twelve additional types from Great Britain had bee known. The researches of the exhibitor during t ten years have revealed the fact that at least fifty types had lain unrecognised in various museu private collections. These include seventeen f Palæodictyoptera, one doubtful representative of M mitoidea; five genera of Protorthoptera, one g Protoblattoides, seven genera and fifteen spe Blattoids, and two examples of Protodonata, inclu wing fragment of Meganeura radstockensa, having expanse, when perfect, of 16 inches. Certain forms are also known with rudimentary wings, an segmented bodies. The insect fauna of the Briti Measures, when better known, will probably prove t extensive and varied as that of the Continent. photographs exhibited were made by Mr. J. W. Tu

Prof. R. Newstead, F.R.S. Samples of Mite-i Flour.

Flour which is heavily invested with mites ( *Aleurobius farinæ*) is certainly ruined. It has unpleasant odour, and in the early stages becom coloured owing to quantities of excrement with wh is charged. (*a*) Illustrates the early phase of infes (4th-7th week). A preparation of this is exhibited the microscope. (*b*) Illustrates a more advanced st the infestation. (*c*) Flour in the final stage of (9th-10th week). Prevention from attack may be s by storing flour with a low moisture content; *i.e.*, 11 per cent in the temperate zone, and from 6—7 pe in the tropics.

The Hon. Sir Charles Parsons, F.R.S. Hammer Cone demonstrating the Destructive Eff Collapsing Vortex Cavities.

The apparatus consists of a hollow cone. At the end is fitted a die cap through which passes a hole c same diameter as the small end of the cone. Be this cap and the cone thin metal plates are inserted. cone is placed in water in the tank, allowed to fill water, and then thrust quickly downwards, its m striking on to a rubber block at the bottom. The su arrest by the rubber block gives a high rate of rel acceleration of the water in the cone, producing moment a cavity at the apex which, however, immediately c again with a perceptible metallic hammering sound, with sufficient pressure, due to the concentrated ener the closing cavity at the apex, to puncture metal p above 0·03 in thickness, indicating a pressure of 140 per square inch.

Mr. Edwin Edser. The Concentration of Min and Coal by Froth Flotation.

Many valuable minerals, particularly metallic sulphi can be concentrated from low-grade ores by crushing t to a fine powder, mixing them with water, adding a s quantity of a suitable reagent, and agitating the mix so that air is entrained in the form of fine bubl On allowing the mixture to come to rest, the bubl carrying the mineral particles, rise to the surface and

neralised froth which can be removed. The barren (gangue) is not floated. (1) The recovery of galena (sulphide) and blende (zinc sulphide) as separate pro...s from Broken Hill ore. (2) The recovery of coal ...n waste dumps.

...he demonstration was a remarkable one and perfectly ...cessful. Music, speech, and gramophone records were ...ived from Chelmsford, and rendered audible to the ...pany in the lecture room with such clearness that it ...s difficult to realise that the sender was not in the ...m. Many other sounds which the lecturer laughingly ...d might be signals from Mars were also heard, but they ...e very indistinct and did not cause inconvenience.

## NOTICES OF BOOKS.

*Text book of Inorganic Chemistry.* Edited by J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C. Vol. IX., Part I. By J. NEWTON FRIEND. Pp. xvii+307. 1920. London: C. Griffin and Co., Ltd., Exeter Street, W.C. 2.

...LUME IX. of "A Text-book of Inorganic Chemistry" is ...blished in two parts, the first part dealing with the ...ments which occur in Group VIII. of the Periodic ...ble with the exception of iron, to which is apportioned *separate part* (Part II.); therefore this part includes ...balt, nickel, and the elements of the platinum group.

The book is divided into ten chapters, each of the first ...ne dealing with an element and its compounds. Chapter ... gives the detection and estimation of the platinum ...etals, which include ruthenium, rhodium, palladium, ...mium, iridium, and platinum itself. In the first place ...e detection and estimation of the separate elements is ...scussed; following on this is given a complete separa...on of the platinum metals both qualitatively and ...antitatively. Two schemes are given for the former, ...d also two for the quantitative separation, one recommended by Mellor and the other by Wunder and ...hüringer.

As a book of reference it should prove of great advantage, ...d to those chemists and students of chemistry whose work ... research into the elements and their compounds given ... the work its aid should be invaluable. To aid the re...arch chemist very thorough references are given to ...iginal literature.

The publishers must be complimented on the way in ...hich the book is got up and its freedom from errors.

*...lementary Practical Chemistry.* By J. E. MYERS, D.Sc. (Vict.), A.I.C., and J. B. FIRTH, M.Sc. (Vict.), A.I.C. 2nd Edition. 1920. Pp. viii+194. London: C. Griffin and Co., Ltd., Exeter Street, W.C. 2. Price 4s. 6d.

...HE authors, in this second edition, have thoroughly ...vised the book which first appeared in 1914.

It is especially intended for medical students and also ...or those studying pharmacy, as well for students in...ending to take the Matriculation, Science and Arts, or ...ntermediate B.Sc.

The book is divided into four parts:—(1) General ...Methods of Chemical Manipulation; (2) Inorganic Quali...ative Analysis, all experiments being based on observation ...nd inference; (3) Inorganic Quantitative Analysis, in...luding examples in both Gravimetric and Volumetric ...ork; (4) Practical Organic Chemistry, containing all ...hat the medical student is likely to require.

These divisions give a good idea of the scope that the ...ook embraces.

Taking the various parts separately, the first part gives ...he student a thorough idea of the terms used in chemistry, such as "Precipitation," "Crystallisation," &c. Further, it gives the general methods adopted for preparing simple substances. The usual common salts are given, and their mode of preparation is clearly explained, the weights being given for most economical working.

Part II. on "Qualitative Analysis" is divided into the analysis of substances by dry reactions, and, secondly, by "group" reagents. This portion, which covers 70 pages, is well thought out and gives the student a thorough groundwork.

The part on "Quantitative Analysis" is perhaps not up to the standard of the rest of the book, more thought being centred on Volumetric Analysis, only 10 pages being devoted to gravimetric exercises. The chapter includes Acidimetry and Alkalimetry, Iodometry, and a few special cases of analysis by the use of indicators and standard solutions. A short account on Colorimetric Estimation is also inserted.

The remainder of the book deals with qualitative organic analysis, which is first of all treated by taking definite examples and giving their specific reactions and then by a methodical examination of an unknown compound.

In an appendix are given tables of melting points, boiling-points, and vapour pressure of water at different temperatures, and international atomic weights.

The book can be well recommended to any student of preliminary or intermediate chemistry.

*Chemistry Lecture Notes.* By G. E. WELCH, M.A. B.Sc. Pp. iv+63. 1919. London: Blackie and Son 50, Old Bailey. Price 2s.

THE author has endeavoured in this little book, containin... rather more than 60 pages, to put into a concise forn... the most important features of a series of lectures i... chemistry that would be given to students during thei... third and fourth years' work in secondary schools an... evening classes. He has endeavoured to cover th... syllabuses of the Senior Oxford and Cambridge Local... College of Preceptors, and Board of Education.

As regards the information contained therein it i... accurate, and, although brief, it covers what it is intende... to do.

In the preface the author remarks:—"I have bee... prompted to publish them (the above) by the fact th... much valuable time is wasted in note-taking—time whic... could be more profitably spent in writing essays on th... various subjects."

We do not think that the author is justified in takin... this view of note-taking. The taking of notes by schola... should make them feel that they are dependent on the painstaking, and by this means they would give mo... attention to the lecturer's discourse. By giving t... scholar his notes in the above form, which he or s... knows to be complete and in every way correct, mo... reliance would be given to the notes than to the lectur... which, in our opinion, should be avoided as much possible.

Another point of argument that can be raised on t... subject of note-taking is—In setting out chemistry in t... manner, does it not tend to make the student, wh... studying for an examination, knowing that all he or s... wants to know is in the book, to learn by heart the wh... of its contents in a parrot-like fashion, the student there failing to learn by reasoning power?

ALSATIAN POTASH.—The Department of Overseas Tra... is informed that the estimated output of Alsatian pota... in the years 1920, 1921, and 1922 will amount to ... following quantities:—1920: 1,320,000 tons, or 220,... tons of pure potash. 1921: 2,040,000 tons, or 340,... tons of pure potash. 1922: 2,340,000 tons, or 390,... tons of pure potash.

## NOTES.

Royal Institution.—On Tuesday next, May 25, at three o'clock, Major C. E. Inglis begins a course of two Lectures at the Royal Institution on the "Evolution of Large Bridge Construction." On Thursday, May 27, Mr. William Archer delivers the first of two Lectures on "Dreams, with Special Reference to Psycho Analysis." On Saturday, May 29, Prof. J. H. Jeans commences a course of two Lectures on "Recent Revolutions in Physical Science—(1) The Theory of Relativity; (2) The Theory of Quanta." The Friday Evening Discourse on May 28 will be delivered by Prof. W. L. Bragg on "Crystal Structure," and on June 4 by Sir Ronald Ross on "Science and Poetry."

Institute of Metals.—An invitation from the Mayor and Corporation of Barrow-in-Furness to hold the Annual Autumn Meeting of the Institute of Metals in that town on Wednesday and Thursday, September 15 and 16 next, has been accepted by the Council of the Institute. Particulars of the meeting can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, S.W. 1, who will also be glad to forward tickets for the Tenth Annual May Lecture, which will be delivered by Prof. C. A. F. Benedicks, Ph.D., Stockholm, Sweden, at 8 p.m. on June 10, at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, the subject of the Lecture being "The Recent Progress in Thermo Electricity." The President, Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D., will preside, and light refreshments will be provided after the lecture. Prior to the lecture a ballot for the election of members and students will take place. Persons so elected will be entitled to be present in their capacity as members or students, respectively, both at the lecture and the Barrow Meeting, whilst their first annual subscription will cover the extended period ending June 30, 1921. Membership forms, or copies of the new illustrated membership booklet, can be obtained from the above address. Students of metallurgy, though they may have exceeded the normal age limit of twenty-five, may apply for student membership, provided that their course of studies was interrupted by the war; students so elected may remain in the category of student members up to June 30, 1923, so long as they continue to be students of a recognised school of metallurgy. This concession represents a valuable financial saving. An additional advantage of membership of the Institute of Metals has just been conceded by the Council. It has been arranged that members and students of the Institute are henceforth at liberty to attend the meetings of any of the several local sections, which exist throughout the country, without further payment beyond their ordinary subscription to the Institute. Members and students receive cards of admission to, and programmes of, the meetings of the various local sections.

The Foundation of an Institute of Physics.—The need has long been felt for a corporate body analogous to the Institute of Chemistry which would represent the profession and strengthen the position of workers engaged in physics, and which would also form a bond between the various societies interested. At present the physicist is hardly recognised as a member of one of the professions, but the vital importance of many developments of physics during the war and the certainty of its growing importance both in science and industry are bringing about a change in this respect. It is one of the aims of the new Institute of Physics to secure recognition of the position and value of the physicist, and it is felt that such recognition can only be obtained by the co-operative action of all the physicists in the country. The Institute has been founded by the co-operation, in the first instance, of the Faraday Society, the Optical Society, and the Physical Society of London, and the first Board is constituted from representatives appointed by the Councils of these Societies. It is hoped that in the course of time other Societies will associate themselves with the Institute. Members Institute who are also members of more than one co-operating Societies will obtain a reduction to t scription to those Societies. There will be three of members: Ordinary Members, Associates (A. I and Fellows (F. Inst. P). Only the two latter membership of which will require full professional cations, will be Corporate Members. The Institu already received promises of support from leading phy and the initial expenses are covered by a Guarantee amounting to over £1200. The first President Institute is Sir Richard Glazebrook, K.C.B., F Sir Robert Hadfield, Bart., F.R.S. is Treasurer, and A. W. Porter, F.R.S. Honorary Secretary. The members of the Board are:—Dr. H. S. Allen, Inst. mander T. Y. Baker, R.N., Prof. F. J. Cheshire, C Dr. R. S. Clay, Mr. W. R. Cooper, Prof. W. H. I Major E. O. Henrici, Dr. C. H. Lees, F.R.S., I C. Paterson, O.B.E., Major C. E. S. Phillips, I H. Rayner, Mr. T. Smith, and Mr. R. S. Whipple. S. Spiers has been appointed Secretary to the Ins and further particulars and Forms of Applicatic Membership may be obtained from him at 10, Essex S Strand, W.C. 2.

British Industries Fair.—The President of the of Trade has received from Mr. Sidney J. Sandle, of M Sandle Brothers, a signed memorandum from th hibitors at the British Industries Fair recently held Crystal Palace, "expressing their thanks to the offici the Board of Trade who were responsible for the su ful organisation of the Exhibition, their testimony t benefit it has been to British trade, and their desire t shall be continued in future years under Govern control." The signatures number nearly one thou and more could have been obtained had time perm Sir Robert Horne, in his reply to Mr. Sandle, stated from the reports which have reached him there seer be no doubt that the Fair has again been a success the point of view of the orders booked, and that gratifying to him to learn that the organisation met the Exhibitors' approval. He points out that in 191 Exhibitors approached Mr. Runciman, who was President of the Board of Trade, with the request tha Fair might be continued annually, and Mr. Runc promised that so long as British manufacturers were pared to support the Fair, the Department would con to do their part. Ever since that day the support by manufacturers has steadily increased, and Sir R sees every reason to think that the Fair may nov regarded as a permanent institution.

Nitrate Market in Chile.—The nitrate mark reported to be in a flourishing condition, and the futu looked upon as being particularly bright. Owing to fact that it appeared latterly that the demand for ni was going to exceed the supply, and that if sales were made with some sort of limitation shippers might themselves short of quantities to be delivered, it was cided by the Association of Nitrate Producers that should offer in the open market the limited quanti 100,000 tons of nitrate, delivery in equal quantities in and June. As a result of this call for tenders offers received in London and Valparaiso amounting to a of 461,000 tons. *El Mercurio* of April 13 announces tha highest offer for the 100,000 tons, which has been accep was received from a firm in Liverpool, being for 100,00 95 per cent at 12s. 9½d. delivery in equal quantities and June. The fact that this sale has been concluded May and June delivery, which are usually bad month considered a further indication of the healthy conditio the market. It is anticipated that prices will continue with a rising tendency. Comparing cost of produc before the war and actual increased cost to-day, the p of 12s. 9½d. now obtaining would only be equal to abou on a pre-war basis. There seems to be only one facto a gloomy nature in the nitrate outlook, and that is pos

arising from the lack of transport facilities on the s working in this zone. According to statistics hand the total exports of nitrate during the year mounted to 20,374,691 Spanish quintals, of which 06, or about one-third of annual export, were d during the month of December.

...GS AND CHEMICALS IN TURKEY.—In the following to the Department of Overseas Trade H.M. Com l Secretary to the British High Commission in ntinople reviews briefly the prospects for trade in :als and drugs in the Turkish market. The Com .l Secretary states that Turkey consumes a large ty of Chemical produce, including drugs, specialities, l kinds of pharmaceutical products, all of which are ted from abroad, for no chemical industries of any xist in the country itself. Germany supplied nearly : cent of the chemical products consumed on the t before the war, and ranked first also in the supply thetical products which are greatly appreciated by edical profession in this country. Nearly all the an manufacturers are very well represented locally ents, of the same nationality, and long established in Constantinople and other important towns of y, besides which each factory sent round yearly lers for the purposes of propaganda and of intro- g their new products. The same propaganda work lso carried on regularly by sending pamphlets and es to all doctors and druggists direct to their address gh the Post Office. In addition the German manu 'er has been made to understand that it was essential ow long credits to their clients in Turkey. A further n for German success was the fact that the manufac- bad studied the requirements of the Eastern tries and prepared special products which answered : exigencies of the French Pharmacopœia, which is ally recognised in this country. The better known an manufacturers working in Turkey are E. Merck, ayer, Meister Lucius and Bruning, Gehe and Co., el and Co., Schering, Zimmer, Boheringer and Sons. g the war the market of Constantinople was flooded German produce and the German military had in p session important stocks, which to a great extent the Armistice were sold by them to private firms, an important quantity was consigned by them, on evacuation, to the Ottoman Government. Fifteen ago British chemical goods were quite unknown urkey, except for a little quinine salt and some phar- :utical specialities, which were imported in small tities only. The British manufacturers were totally ting the market of Turkey. If by any chance any gist filed an order with a British firm, he was obliged y half the value of the goods when ordering and the ice against documents at Constantinople. British bad no agents in Turkey and never sent out travellers :t a footing in the market. It was only in 1908 that ks to the establishment of a drug store for British ucts that the United Kingdom started exporting to ey. Then local purchasers soon realised the advantages hese products, and although competition with the nan article was very keen, British goods held the ket in a comparatively short lapse of time. This was situation at the declaration of war. Since the Armistice ness relations with British firms have again recom- ced and the results obtained are satisfactory in con- :ing the fact that the majority of British factories have got any stock available for export to Turkey, and les which they insist on the counter-value of goods red to be paid for beforehand or by confirmed credits ondon. This mode of business does not in any way urage the buyers out here, and therefore preference is n to French firms who accept orders cash against ments, and in some instances after arrival of goods. nch chemical products represented 20 per cent of the mmption, but in addition to this, France exported into key 75 per cent of all pharmaceutical specialities. The tion to-day is that France has slipped in to replace Germany, for the reason, as stated above, that the terms offered are more favourable to the market than those offered by British manufacturers. The rate of exchange of the franc, it is true, was very advantageous to the importers, and it must not be forgotten that the French products adapt themselves admirably to the use of this country, and in addition special facilities are granted, such as the expediting of chemical products by post as registered samples, while British firms do not enjoy this facility and are obliged to pay the Custom House dues when the French are not. For British manufacturers to regain their immediate pre-war percentage of the imports into Turkey of chemical products, the United Kingdom exporters must study the wants of this country and get into touch with a British firm of good standing established in Constantinople, to act as their agents. They should adopt a new packing system on the metric basis and their products should answer the requirements of the French Pharmacopœia. While export from Germany is impossible now is the time of the British manufacturer's opportunity, and no time should be lost in introducing his products to the Turkish Market.

## MEETINGS FOR THE WEEK.

*Tuesday, May 25.*

Royal Institution, 3. "The Evolution of Large Bridge Construction," by Major C. E. Inglis.

*Thursday, May 27.*

Royal Society, 4.30.

Royal Institution, 3. "Dreams—with Special Reference to Psycho-Analysis,' by William Archer.

*Friday, May 28.*

Royal Institution, 9. "Crystal Structure," by Prof. W. L. Bragg.

Royal Society of Arts, 4.30. (Indian and Colonial Section). "Lignite," by Prof. W. A. Bone.

Physical Society, 5.

*Saturday, May 29.*

Royal Institution, 3. "The Theory of Relativity," by Prof. J. H. Jeans.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Technical School, Dewsbury,
May 7, 1920.

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A schedule of duties may be obtained from the Director of Education, Education Offices, 14, Sir Thomas Street, Liverpool, and applications should be received by him NOT LATER THAN MAY 24.

E. R. PICKMERE,
Clerk to the Local Education Authority.

Physical Chemist wanted to specialise in Research Work on Refractories.—Write, with full statement of qualifications, Box 1384, Sell's Advertising Offices, Fleet Street, London, E.C. 4.

G. R.

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Tenders to be returned not later than 10 a m. on SATURDAY, MAY 29, 1920.

NOTE.—For particulars of other Government Property for sale see "SURPLUS," price 3d. at all bookstalls, or by quarterly subscription of 2/- post free, payable in advance to the Director of Publicity, Ministry of Munitions Whitehall Place, London, S.W. 1.

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If in good condition, Sixpence per copy will be paid for any of the undermentioned numbers of the CHEMICAL NEWS which may be forwarded to this office:—

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3056, September 13th, 1918.
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3061, December 6th, 1918.
3063, December 20th, 1918.
3064, January 3rd, 1919.
3066, January 17th, 1919.
3068, January 31st, 1919.
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## NOTICES.

**EDITORIAL.**—All Literary communications, and Books, Chemical Apparatus, &c., for review or notice to be addressed to the EDITOR.

**SUBSCRIPTIONS**, £1 per annum, payable in advance, should be addressed to the MANAGER.

**BACK NUMBERS and VOLUMES** can be purchased on application to the MANAGER.

**ACCOUNTS** for Advertisements up to March 31 should be paid to the MANAGER.

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All communications for this Department should be addressed to—

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THE CHEMICAL NEWS

VOL. CXX., No. 3137.

# BRANNERITE, A NEW URANIUM MINERAL.*

By FRANK L. HESS, A.B., and ROGER C. WELLS, Ph.D.
United States Geological Survey.

[...]s S. M. Ballard sent to one of the writers a highly [...]ctive mineral that had been obtained from gold [...]s worked by Henry Sturkey in Stanley Basin in the [...]l part of Idaho. Later, other material was sent to [...]rvey by Mr. Sturkey. Mr. Sturkey's placer is near [...]ad of Kelley Gulch, said to be in granite cut by [...]tites, and it is in the pegmatites that the source of [...]ineral is probably to be found.

[...]916 Robert N. Bell published a half-tone of a radio- (*Sixteenth Ann. Rep. Mine Inspector of Idaho*, 1915, pp. 29, 30) made with the mineral by A. G. Van[...], who thought it to be euxenite, with which it is [...]d in composition and which it resembles in colour [...]xture.

[...] mineral received is in grains, part of which are [...]s and most of which show a prismatic tendency. [...] are a brownish yellow on the outside, but the visible [...]ering has extended to a depth not exceeding the [...]ess of paper. Inside they are brilliant black, a conchoidal fracture and no sign of cleavage. [...]ed specimens examined under reflected light show [...]ineral to be remarkably homogeneous. It is, how[...] traversed by minute cracks that are in part filled by [...]z that undoubtedly accounts for the $SiO_2$ in the [...]sis. Although to the eye the mineral is an opaque [...], under the microscope very thin chips allow sufficient [...]wish green light to pass to make possible optical [...]urements. The streak is a dark greenish brown. [...] hardness is about 4·5, as the mineral will scratch [...]te but will not scratch orthoclase.

[...]e crystals are not perfect enough to allow a deter[...]tion of the crystal form, but their shapes suggest that [...] may be orthorhombic or tetragonal. However, E. S. [...]en determined it to be isotropic with an index of [...] 2·26 ± 0·02 and nNa = 2·30 ± 0·02. It seems prob[...] that it is an isometric paramorph after either a [...]gonal or an orthorhombic form as many of the [...]plex pegmatitic uranium minerals seem to be. It will [...]oted in the tables given in the article that all but one [...]e minerals (bielmite) are isotropic. Yttrocrasite shows [...]ringent particles and is probably a mixture. Also [...] nearly all of the complex pegmatite minerals the new [...]ral is variable in composition, and the specific gravity [...]e specimens tested ranged from 4·5 to 5·43, as deter[...]d with the Joly balance. The specimens analysed [...] a specific gravity of 5·42 (by pyknometer).

[...]he radio-activity of the specimens of different specific [...]ities showed slight differences as tested by the [...]sure of a photographic plate. Those having the [...]est specific gravity appeared most active. The [...]erial was not tested in an electroscope. Attention [...] be called to the advantages of making a radiograph [...]various specimens in a case of this sort before pro[...]ling with the analysis, as some of the pieces were com[...]tively inactive, and pieces with a like content of [...]nium or thorium, or both, may be readily selected. Two [...]he least active pieces gave, on analysis, 35·0 per cent. [...]$_2$ compared with 39·0 per cent in the best material.

If in quantity the mineral would be of value as a source of radium, but probably only a few pounds could be obtained even at a prohibitive cost.

*Chemical Analysis.*

Our thanks are due to Mr. W. C. Wheeler for preliminary chemical determinations on the mineral. Mr. Wheeler established the presence of uranium and suggested the separation of titanium and uranium by hydrolysis, as finally carried out.

The mineral is slowly decomposed by treatment with concentrated sulphuric acid, or by hydrofluoric and sulphuric acids. It is more convenient, however, to bring it into solution by gentle fusion with acid sodium sulphate. On dissolving the melt in cold water, or dilute sulphuric acid, there remains a small residue consisting of silica, unattacked mineral, and sulphates of lead, barium, and strontium, which was analysed separately.

Various methods of analysis were tried, using principally the acid sulphate solution, but the unusual association of elements made the analysis largely a process of successive approximations. Each precipitate obtained was tested for impurities, and if an admixture was found the method of analysis was modified accordingly.

It was thought at one time that the ammonium carbonate treatment could be relied on to separate the main constituents, uranium and titanium, but so much titanium was carried into the filtrate with the uranium in this process that it was decided to separate the titanium by hydrolysis. The precipitate and filtrate were then further analysed separately.

For the hydrolytic separation of titanium the sulphate solution was treated with hydrogen sulphide, neutralised, freed from hydrogen sulphide with a stream of carbon dioxide, and finally diluted and boiled after the addition of considerable ammonium sulphate (W. F. Hillebrand, U.S. Geol. Survey, *Bull.* 422, 137, 1910).

In one analysis 3·1 per cent of rare earths was found in the titanium separated as described, and 5·0 per cent in the uranium portion. In another analysis the total rare earths separated directly, first as fluorides, and finally as oxalates, amounted to 8·0 per cent.

The filtrate from the titanium was precipitated twice with ammonium hydroxide, leaving calcium in solution. The hydroxides were dissolved in hydrochloric acid, evaporated nearly to dryness, taken up in hydrofluoric acid, and the rare earths filtered off. After removing hydrofluoric acid with sulphuric acid, precipitating with ammonia, and dissolving the hydroxides in nitric acid, the remaining elements, chiefly uranium, were subjected to the ammonium carbonate treatment, and uranium was finally separated and weighed as pyrophosphate.

The stage of oxidation of the uranium in the mineral was determined separately by decomposition with dilute sulphuric acid in a closed glass tube containing carbon dioxide at 225° C. and subsequent titration with potassium permanganate. It was assumed in calculating the proportion of $UO_2$ that all the iron of the mineral was in the ferrous condition. The only ground for this assumption is the fact that iron is more easily reduced than uranium, so that the existence of any uranous oxide would imply the absence of ferric oxide. However, the state of oxidation of the iron cannot be regarded as determined. The coating on the grains contained some ferric oxide which could only be removed by carefully chipping off the exterior and selecting the jet black pieces. A determination of iron as $Fe_2O_3$ on unselected material gave 3·7 per cent, whereas the value obtained on the best selected material was 3·0 per cent, or 2·7 per cent FeO. Iron seems to be an essential constituent of the mineral. In the extended analysis iron had to be determined in the titanium portion, in the ammonium carbonate precipitate, and in the uranium precipitate.

Thorium was determined in the mixture of rare earths by the sodium thiosulphate method. The ignited oxide

* Published by permission of the Director of the United States [Geo]logical Survey. From the *Journal of the Franklin Institute*, [Feb]ruary, 1920.

was white, and pure as far as could be determined. The yttrium earths were estimated by their solubility in a solution of sodium sulphate. They were a buff colour after ignition, and gave by conversion of the oxides to sulphates an average atomic weight of 151, a weight so great that probably erbium or ytterbium or both are present. Lack of time prevented a thorough investigation of the rare earths. No cerium earths could be detected. Water and carbon dioxide were weighed in absorption tubes after heating the mineral in a boat in a hard glass tube in a current of dry air. A small correction was applied based on the results of blank determinations run similarly. No magnesium, tin, tungsten, tantalum, columbium, molybdenum, vanadium, copper, or fluorine could be detected.

An attempt was made to heat the mineral, mixed with carbon, in a stream of chlorine, and make a fractional condensation of the volatile chlorides. A complete separation of the uranium and titanium was not accomplished, but the non volatile residue in the boat was found to contain calcium, rare earths chiefly of the yttrium group, iron, and a little uranium.

An attempt was also made to detect helium but without success. On heating 5 grms. of the mineral with acid sodium sulphate in a vacuum a few cc. of gas were obtained—largely sulphur dioxide, which was probably generated by the action of the $UO_2$ on the sulphuric acid. Nearly all of the gas was soluble in a solution of sodium hydroxide, and what remained gave only nitrogen lines, as far as could be determined, when examined in a Pluecker tube.

The various determinations led to the results given in Table I.

Table I.—*Composition of the Mineral from Stanley Basin.*

(R. C. Wells, Analyst).

| | Per cent. | Molecular values. |
|---|---|---|
| $SiO_2$ | 0·6 | 0·010 |
| $TiO_2$ | 39·0 | 0·488 |
| FeO | 2·9 | 0·040 |
| CaO | 2·9 | 0·052 |
| $UO_2$ | 10·3 | 0·038 |
| $UO_3$ | 33·5 | 0·116 |
| $ThO_2$ | 4·1 | 0·015 |
| $Ce_2O_3$ | None | |
| $Yt_2O_3$, &c. (*a*) | 3·9 | 0·011 |
| $ZrO_2$ | 0·2 | 0·001 |
| PbO | 0·2 | 0·001 |
| BaO | 0·3 | 0·002 |
| SrO | 0·1 | 0·001 |
| $H_2O$ | 2·0 | 0·111 |
| $CO_2$ | 0·2 | 0·005 |
| $Fe_2O_3$, $Al_2O_3$, $P_2O_5$ | Trace | |
| | 100·2 | |

Specific gravity, 5·42.

(*a*) Average molecular weight, 350.

*Calculation of Formula.*

The combinations in molecular values seems logical (Table II.).

Table II.

| | | | | | |
|---|---|---|---|---|---|
| FeO | 0·040 | $UO_2$ | 0·038 | $CO_2$ | 0·005 |
| CaO | 0·052 | $ThO_2$ | 0·015 | $SiO_2$ | 0·010 |
| BaO | 0·002 | $ZrO_2$ | 0·002 | $TiO_2$ | 0·488 |
| SrO | 0·001 | | | | |
| PbO | 0·001 | | 0·055 | | 0·503 |
| | 0·096 | | | | |

This leaves $Yt_2O_3$ = 0·011, $UO_3$ = 0·116, and $H_2O$ = 0·111 ungrouped. On this basis the mineral may be si[...] as shown in Table III.

Table III.

| | | | |
|---|---|---|---|
| RO | 0·096 | | 8·7 |
| $Yt_2O_3$ | 0·011 | | 1·0 |
| $RO_2$ | 0·055 | or | 5·0 |
| $UO_3$ | 0·116 | | 10·5 |
| $TiO_2$ | 0·503 | | 45·7 |
| $H_2O$ | 0·111 | | 10·1 |

Without any further combination this yields [...]lowing approximate formula :—

$$9RO.\ Yt_2O_3.\ 5RO_2.\ 11UO_3.\ 46TiO_2.\ 10H[...]$$

The figures for RO and $UO_3$ are not very near [...] numbers, but this need cause no disappointment [...] whole calculation rests on the assumption that t[...] is in the ferrous condition. Although this assumpt[...] certain analogies to support it and is given prefer[...] would not be entirely unreasonable to assume that [...] all of the iron is in the ferric condition. The q[...] cannot be settled experimentally in the prese[...] uranium in two stages of oxidation. If all of the [...] assumed to be present as ferric iron the percentag[...] molecular values in Table IV. are obtained in p[...] those first given.

Table IV.

| | Per cent. | Molecular val[...] |
|---|---|---|
| FeO | None | — |
| $Fe_2O_3$ | 3·2 | 0·020 |
| $UO_2$ | 18·4 | 0·068 |
| $UO_3$ | 25·1 | 0·089 |

Appropriate grouping now leads to the appr[...] formula :—

$$2RO.\ R_2O_3.\ 3RO_2.\ 3UO_3.\ 18TiO_2.\ 4H_2[...]$$

The bases are apparently present as titanates, [...] titanates, or uranotitanates, but an exact evaluation [...] relative proportions of these compounds is obvious[...] difficult and hardly appears practicable in view [...] uncertainty concerning the stage of oxidation of t[...] and uranium. There is more $TiO_2$ present than [...]quired to form normal titanates of all the bases, b[...] enough to form metatitanates without taking [...] uranium as the basic radicals UO and $UO_2$. To [...] an exact balance any excess of $TiO_2$ may be redu[...] the form of a titanyl metatitanite, $TiO.TiO_3$.

The results given in Table V. are presented for il[...]tion as one of the possibilities along this line with li[...] recommend it over others that could be given.

Table V.

| Oxide. | Molecular value. | Metatitanate. | TiC[...] requi[...] |
|---|---|---|---|
| RO | 0·096 | $RTiO_3$ | 0·0[...] |
| $Yt_2O_3$ | 0·011 | $Yt_2(TiO_3)_3$ | 0·0[...] |
| $ThO_2$ | 0·016 | $Th(TiO_3)_2$ | 0·0[...] |
| $ZrO_2$ | 0·001 | $Zr(TiO_3)_2$ | 0·0[...] |
| $UO_2$ | 0·038 | $UOTiO_3$ | 0·0[...] |
| $UO_3$ | 0·116 | $UO(TiO_3)_2$ | 0·2[...] |
| $TiO_2$ | 0·070 | $TiOTiO_3$ | 0·0[...] |
| | | | 0·5[...] |

On this basis the mineral may be represented [...] hydrated metatitanate of various bases, thus :—

$$(Ca,Fe,UO,TiO)TiO_3 + (Th,Zr,UO)(TiO_3)_2 + \\ + Yt_2(TiO_3)_3 + [...]$$

Without implying exact molecular ratios the propo[...]

ese four species would be about 6, 8, 1, 3 respectively. ould be remembered, however, that the stage of tion of the iron is unknown, and this ignorance intro- uncertainty in these proportions. Nor is it known ner minerals of this kind should be considered as l crystals, solid solutions, or salts of complex acids, ugh in one of these suppositions may lie the correct nation of their composition.

aborate Tables will be found in the original giving nparative Analyses of the Complex Uranium rals").

e newly described mineral from Idaho is designated nnerite. The new mineral contains more uranium any other except the pitchblendes. Unlike most of thers it contains no tantalum or columbium and is high in titanium.

: only other minerals having the same general ative composition are zirkelite and delorenzite, and ake comparison easier their analyses are repeated e VI.).

ABLE VI.—*Analyses of Zirkelite, Delorenzite, and Brannerite.*

| | Zirkelite isometric. | Delorenzite orthorhombic. | Brannerite undetermined. |
|---|---|---|---|
| fic gravity | 4·741 | 4·7 | 5·42 |
| .. .. | 14·95 | 66·03 | 39 0 |
| .. .. | 1·40 | 9·87 (a) | 10·3 |
| .. .. | — | — | 33·5 |
| 3 .. .. | 2·52 | — | — |
| .. .. | 0·21 | 14·63 | 3·9 |
| .. .. | 7·31 | — | 4·1 |
| .. .. | 52·89 | — | 0·2 |
| .. .. | — | — | 2 9 |
| .. .. | 0·22 | — | — |
| .. .. | — | 4·33 | — |
| .. .. | 7 72 | 4·25 (a) | 2 9 |
| .. .. | — | — | 0·2 |
| ± .. .. | 1·02 (ign.) | — | 2·0 |
| .. .. | 10·79 | — | — |
| .. .. | — | — | 0 6 |
| .. .. | — | — | 0·3 |
| .. .. | — | — | 0·1 |
| .. .. | — | — | 0·2 |
| 3 .. .. | — | — | Traces |
| .. .. | — | — | Traces |
| .. .. | — | — | Traces |

(a) State of oxidation not determined.

: uranium in zirkelite is almost negligible, and the ity of zirconium present puts it in a class by itself. analysis of delorenzite makes the mineral appear it suspiciously simple in composition, only five metals determined, but the relationship to brannerite is than that of zirkelite. However, the quantity of um oxide is less than one-sixth that of the titanium , but in brannerite the weight of uranium oxides is r than that of titanium oxide and is more than four as great as that in delorenzite.

: new mineral seems worthy of an individual name, we therefore propose to call it brannerite after Dr. Branner, formerly head of the Department of gy and Mining and President of Stanford University. nnerite may be described as a complex titanate of um with smaller quantities of rare earth and other s, in which the weight of uranium oxides exceeds f titanium oxide.

E Bakerian Lecture will be delivered by Sir Ernest rford, F.R.S., at the Royal Society on Thursday h, at 4.30 p.m., on "The Nuclear Constitution of toms."

## AGGREGATION AT THE MELTING POINT.

By WILLIAM R. FIELDING, M.A., M.Sc. (Vict.), Senior Science Master at King Edward VII. School, Lytham.

(Continued from p. 242).

*First portion of the Curve (2° to 171·5°).*

The elements which lie on this portion of the curve are helium, hydrogen, neon, fluorine, oxygen, nitrogen, argon, krypton, xenon, and chlorine. No direct observations of their specific heats at their melting points have been made, but from the study of their compounds their atomic heats at "ordinary temperatures" have been calculated to be—

5·9 for chlorine,
5·3 for nitrogen,
5 for fluorine,
4 for oxygen, and
{2·3 (Kopp) for hydrogen,
{2·7 (Tilden).

As atomic heats decrease with fall of temperature, their values at their melting points will be considerably less than those stated above. For example, from the variation of the specific heat of alumina with temperature Tilden calculated the atomic heat of combined oxygen to be—

4 at 700° A.,
3·8 at 500° A.,
3·3 at 200° A.,
1 9 at 100° A., and, say,
1·3 at 50° A. (its. M.P.).

From $\frac{M.P. \times s}{R} = 4{\cdot}15$, the values of R and $s$ for oxygen appear to be about 1·06 and 0·08 respectively; but see Table V.

The data in Table V. is largely conjectural and has been obtained by graphing the results in Table IV. and producing the curve backwards, making melticular weights rise with increase of temperature.

*Three facts are brought to light by this Table:—*

(1) The regularity in the behaviour of the argon elements—the specific heat falling and the atomic heat rising as we mount the series.

| | *Spec heat.* | *Atom. heat.* |
|---|---|---|
| He .. .. | 0·5 ? | 2 ? |
| Ne .. .. | 0·186 | 3·72 |
| Ar .. .. | 0·12 | 5·2 |
| Kr .. .. | 0·066 | 5·48 |
| X .. .. | 0·045 | 5·85 |

(2) That as we proceed along the periodic system (from left to right) there is decrease of specific heat with increase in atomic weight.

| | | | |
|---|---|---|---|
| | | H 3·52 | He 0·5 |
| N | 0·37 0·31 | F 0·25 | Ne 0·186 |

(3) That *in every case where observations have been* made the calculated atomic heat is higher than the observed atomic heat. This is very noticeable in the case of oxygen. Here the observed atomic heat at 100° A. is 1·9, so that one would naturally expect it to be about 1·3 at the melting point; but the calculated atomic heat is about four times as much! That is, the observed specific heat will prove to be only one-quarter of the calculated specific heat. Now, in the equation—

$$s = \frac{R \times 4{\cdot}15}{M.P.},$$

if $s$ is four times as big as it should be, then R is also too big (to correspond to the M.P.). It would appear, then, that certain elements are polymerised even at the M.P. (i.e., in the solid state), so that an oxygen polymer, in-

TABLE V.

| Element. | M.P. | Melt. wts. | R. | $s = \frac{R \times 4.15}{M.P.}$ | Atomic heats (observed). | Calc. at. [h…] (at M.P.) |
|---|---|---|---|---|---|---|
| He .. .. .. .. | 2° | 1 ? | 0·25 | 0·5 | ? | 2·0 ? |
| H .. .. .. .. .. | 14 | 12 | 12 | 3·52 | 2·7 between 200—273° | 3·52 |
| Ne .. .. .. .. | 20 | 18 | 0·9 | 0·186 | | 3·72 |
| F .. .. .. .. .. | 50 | 57 | 3 | 0·25 | | 4·75 |
| O .. .. .. .. .. | 55 | 66 | 4·1 | 0·31 | 4 at 700°; 3·3 at 200°; 1·9 at 100° | 4·96 |
| N .. .. .. .. .. | 63 | 78 | 5·6 | 0·37 | | 5·18 |
| Ar .. .. .. .. .. | 85 | 108 | 2·7 | 0·13 | | 5·2 |
| Kr .. .. .. .. | 104 | 138 | 1·66 | 0·066 | | 5·48 |
| X .. .. .. .. .. | 133 | 190 | 1·46 | 0·045 | | 5·85 |
| Cl .. .. .. .. .. | 171 | 248·5 | 7 | 0·169 | 5·9 | 6 |

stead of being represented as $(O)_4$, should be represented by (OOOO), or, perhaps, by—

$$\left(O<^{O}_{O}>O\right).$$

That is, the atom of oxygen, polymerised, behaves as a *single atom* whose atomic weight is 64; so that R for oxygen is really 1 and not 4. Similarly, H is polymerised in the solid state, the melticule being, perhaps, $(H_4)_3$.

(To be continued).

## LEAD AND LEAD OXIDES.

### COLORIMETRIC METHOD FOR THE DETERMINATION OF THE COPPER AND IRON PRESENT.

By CHARLES R. HARDY, Chief Chemist to Messrs. Greenwood and Batley, Ltd.

THE determination of all the impurities in a sample of soft lead or of one of the lead oxides is a delicate piece of work and takes a day or two to carry out, owing to the fact that the impurities consist of minute quantities of a large number of metals. For many purposes, however, the iron and copper content is all that is required, and this may be determined very expeditiously and with a high degree of accuracy by the method given below.

To ensure accuracy, a large sample has to be analysed, and the solution of the sample, followed by the separation of lead as sulphate, constitutes the biggest part of the work. A 200 grm. sample of lead or litharge can be dissolved in a 1½ litre beaker.

Red-lead, however, must be attacked with aqua regia, and to dissolve up the lead chloride that is formed requires great dilution with water. To work with at all reasonable quantities of solution, it is practically impossible to analyse more than a 20 grm. sample of red-lead.

*Solutions.*

Standard Copper Solution:—0·393 grm. $CuSO_4,5H_2O$ per litre. 1 cc = 0·0001 grm. Cu.
Standard Iron Solution:—0·210 grm. ferrous ammonium sulphate per litre. 1 cc = 0·00003 grm. Fe.
Ammonium Nitrate:—10 per cent solution.
Potassium Ferrocyanide:—0·4 per cent solution.
Ammonium Thiocyanate:—5 per cent solution.

A weighed quantity (200 grms. for preference) is dissolved in a nitric acid, s.g. 1·2, with cautious heating. Distilled water is added when necessary to moderate the reaction and to prevent lead nitrate crystallising out. When all dissolved, concentrated sulphuric acid is added (32 cc. per 100 grms. of sample taken).

The solution is filtered by decantation four or five times. 20 cc. of sulphuric acid are added to the filtrate, which is then evaporated nearly to dryness. After cooling, the liquid is diluted with water and filtered from lead [s…] The filtrate is evaporated to low bulk with a few [… of] nitric acid and allowed to cool. Ammonia is the[n added] to precipitate the iron. The precipitate is collect[ed on a] small filter, washed once with water, and re-disso[lved in a] little nitric acid. The iron is then reprecipitated, and washed thoroughly.

The two filtrates from the precipitation of the i[ron con]tain all the copper.

*Copper.*—The filtrates are evaporated to lo[w bulk,] allowed to cool, and made up to the mark in a sma[ll gradu]ated flask. 50 cc. are transferred to a small beak[er, made] ammoniacal, and boiled until quite neutral. Th[e liquid] is cooled, transferred to a Nessler glass, and 5 cc[. of] potassium ferrocyanide solution and 5 cc. of the am[monium] nitrate solution are added. Into the other Nessl[er glass] are put 5 cc. of the ferrocyanide and 5 cc. of the [nitrate.] Distilled water is added until the level is the same [in both] glasses. The standard copper solution is run in [from a] burette until the colours in both tubes correspond.

It is important that the solution to be tested s[hould be] quite neutral. If ammoniacal, no colour is prod[uced; if] acid, the colour is brownish instead of pink.

*Iron.*—The iron precipitate is dissolved in [a small] quantity of nitric acid and made up to the m[ark in a] 250 cc. flask. 25 cc. are transferred to a Nessl[er glass] with 9 cc. of 25 per cent hydrochloric acid and 5 c[c. of] thiocyanate solution. 10 cc. of 25 per cent hyd[rochloric] acid, 5 cc. of thiocyanate solution, and distilled w[ater are] placed in the other glass, and standard iron solu[tion run] in from a burette.

## THE THEORY AND PRACTICE OF LUBRICA[TION]: THE "GERM" PROCESS.*

By HENRY M. WELLS and JAMES E. SOUTHCOMB[E].

(Continued from p. 249).

TABLE I. shows a few results selected from a ve[ry large] number of trials.

A glance at the table shows the surprising fact [that the] *interfacial tension against water of the vegeta[ble and] animal oils is much lower than in the case of a mine[ral oil].*

What is more, we were struck by the fact that we [had found] a test which showed a distinct physical difference b[etween] mineral and saponifiable oils independent of vi[scosity,] density, &c., and this difference appeared to be [in con]formity with the lubricating properties of the oils.

It now remained to enquire what was the reason [of this] difference in tension. After considerable experime[nts] we proved that the lowering of the interfacial

* From the Journal of the Society of Chemical Industry, [M…] 1920.

ainst water in the case of fatty oils was *due to their slight ntent of free fatty acidity.*

Table II. shows some of the results.

ABLE I.—*Table of Interfacial Tension by Drop Numbers of various Oils against Water.*

| OIL. | Mean temperature 70° F. No. of drops at constant orifice and head. | Tension in arbitrary units. | |
|---|---|---|---|
| raffinum liquidum .. | 95 | 100 | Mineral oils. |
| 905 mineral .. .. | 101 | 94 | |
| lar red mineral .. | 102 | 95 | |
| on-viscous neutral .. | 99 | 93 | |
| ive .. .. .. .. .. | 132 | 72 | Fatty oils. |
| pe .. .. .. .. .. | 138 | 68 | |
| conut .. .. .. .. | 161 | 59 | |
| rd oil .. .. .. .. .. | 128 | 73 | |

By removing the free fatty acids from the saponifiable s the tension rises, and by adding free fatty acids to the neral oil *the tension can be lowered.*

TABLE II.

| OIL. | Free fatty acids. calc. as oleic. | Drop number. | Interfacial tension. |
|---|---|---|---|
| 05 mineral .. | nil | 101 | 100 |
| per cent mineral.. per cent commercial fatty acids .. | 1·9 | 125 | 80 |
| per cent mineral.. per cent commercial fatty acids .. | 2·8 | 130 | 78 |
| ve .. .. .. .. | 2·2 | 125 | 80 |
| ve .. .. .. .. | 4·5 | 140 | 72 |
| pe.. .. .. .. | 2·5 | 132 | 76 |
| conut .. .. .. | 4·1 | 148 | 68 |
| ve (neutral) .. | 0·1 | 110 | 92 |
| pe (neutral) .. | 0·15 | 108 | 93 |

low, all commercial animal and vegetable oils contain ll quantities of free fatty acids, and even if the utmost has been taken in refining to remove the acidity, rolysis soon sets in and free acids are formed which, even relatively minute quantity, suffice to lower the ace tension.

able III. shows the percentage of free fatty acids in esentative samples of animal, vegetable, and compounded oils on the market.

able III. is representative of the general glycer- and commercial compounded lubricating oils in y use on all types of power plant, and we see that fatty s are always present to a certain extent. From the going it is demonstrable that :—

Capillary effects (hitherto ignored in lubrication) play a fundamental part.

The presence of fatty acids in an oil lowers the surface tension of said oil against water.

A neutral glyceride possesses a similar tension to a neutral mineral oil.

*The addition of a relatively minute amount of a* fatty acid to a neutral mineral oil reduces the tension to that of a commercial animal or vegetable *oil or compounded lubricating oil.*

ow *it remains to enquire how far these results in*ce the theory and practice of lubrication of solid sur- . It might be argued that the interface between oil water *is a different thing from the interface between* nd metal, and that the conclusions drawn from the ase are not necessarily applicable to the other. As a er of fact such similarity in effect is not unknown in instances, and to obtain more conclusive evidence essor Lewis has measured the interfacial tension be- oil and a liquid metal—mercury. (It should not be forgotten that solid-liquid interfacial tension cannot be measured.) His results are as follows:—Pure neutral mineral oil, 100; same mineral oil plus 2 per cent of commercial fatty acid, 89. It is seen that again there is a lowering in the interfacial tension as a result of the addition of the organic acids, and, what is more striking, the relative lowering produced is very much the same as it is in the case of an oil-water interface.

TABLE III.

| | Acidity (as oleic). |
|---|---|
| Animal oil, pale .. .. .. .. .. .. | 4·2 to 25·55 |
| „ „ brown .. .. .. .. .. | 12·02 to 30·32 |
| Castor, firsts .. .. .. .. .. .. | 0·49 to 1·70 |
| „ seconds .. .. .. .. .. .. | 2·12 to 7·40 |
| Coconut, Cochin .. .. .. .. .. .. | 1·26 to 19·11 |
| Colza, Belgian .. .. .. .. .. .. | 1·97 to 3·22 |
| „ Stettin .. .. .. .. .. .. | 1·41 to 4·48 |
| Lard, pressed .. .. .. .. .. .. | 0·28 to 0·71 |
| Olive oil, Algerian .. .. .. .. .. | 2·52 to 13·72 |
| „ Gallipoli .. .. .. .. .. | 12 to 33·14 |
| Palm oil .. .. .. .. .. .. .. | 24·68 to 56·05 |
| „ bleached.. .. .. .. .. .. | 14·1 to 27·49 |
| Rape oil, Black Sea, refined .. .. .. | 1·82 to 4·34 |
| „ East India .. .. .. .. .. | 1·26 to 4·24 |
| Sperm oil, Arctic No. 1 .. .. .. .. | 0·56 |
| „ „ No. 2 .. .. .. .. | 0·42 to 4·34 |
| „ Southern .. .. .. .. .. | 0·7 to 2·86 |
| Tallow .. .. .. .. .. .. .. .. | 1·55 to 43·71 |

*Standard Brands of Compound Oils on the Market:*

| | Acidity (as oleic). Per cent. |
|---|---|
| Marine engine oil, D .. .. .. .. .. | 1·3 |
| „ „ „ O .. .. .. .. .. | 5·15 |
| „ „ „ T .. .. .. .. .. | 4·5 |
| Motor oil, X .. .. .. .. .. .. | 0·26 |
| „ Y .. .. .. .. .. .. | 0·5 |
| „ Z .. .. .. .. .. .. | 2·5 |
| Compound steam cylinder .. .. .. .. | 0·4 |
| Medium gas and oil engine oil .. .. .. | 0·25 |
| „ „ „ „ .. .. .. | 0·39 |
| Light gas and oil engine oil .. .. .. | 1·6 |
| „ „ „ „ .. .. .. | 1·3 |
| Heavy gas engine oil .. .. .. .. | 1·28 |
| „ „ „ .. .. .. .. | 2·5 |
| Oil engine oil .. .. .. .. .. .. | 0·7 |

Professor Lewis remarks:—"*One may conclude there*fore with some confidence that the addition of the organic acids will lower the tension at any metal-oil interface."

*Again, as already pointed out, the permanency of films is* dependent upon a diminished interfacial tension between the oil and the metal in contact therewith. If such a film is broken the possibility of its uniting again to form an unbroken layer depends entirely upon the interfacial tension being low. Any substance which lowers the interfacial tension causes the liquid to spread over a larger area of the solid. It follows therefore that if a substance be added to *an oil which brings about a lower*ing of interfacial tension, such addition will act favourably as far as lubrication is concerned by preventing a *rupture of the liquid film, and preventing, in turn*, the metals coming into direct contact.

The capacity for spreading may be considered as partly physical and partly chemical, due presumably to residual valency. The effect is to render the transition layer between the liquid and the solid less abrupt. This diminution in abruptness can be brought about by chemical action direct or indirect across the transition layer or by the solubility of some third substance in both phases.

H. S. Allen has recently pointed out that on Langmuir's view oiliness depends on the chemical forces called into play between the *active part of the oil molecule and the* solid surfaces of the bearing.

Now it is obvious that there is a tendency for chemical activity between the metallic surfaces of bearing and journal and an oil containing free fatty acidity, while such tendencies are less pronounced in the case of a neutral mineral oil. Such a tendency would render the transition between oil and solid surfaces less abrupt, would manifest itself by reduced interfacial tension, and would result in better spreading and consequent increased efficiency in lubrication.

There is little doubt in our minds that the physical rationale of the property of "oiliness" is now explained, and we have confined ourselves so far to a statement of the physico-chemical experiments which we have made and to the development of the physical theory.

Conclusive as it appears to us we have proceeded to test and verify the conclusions by direct friction measurements, and finally by the only real touchstone, namely, the test of experience in a long series of practical trials on all types of machinery and prime movers of the very largest sizes.

We will proceed to consider some of the results in detail.

First we beg to tender our thanks to Mr. L. Archbutt for the frictional test made by him, which he has communicated to the Physical Society at its recent discussion on Lubrication.

Archbutt has made a series of determinations of the frictional coefficient on a Thurston machine under a load of 270 lb. per square inch at the very slow speed of 7 feet per minute.

His results are as follows:—Pure mineral oil 0·0047; do. plus 1 per cent rape oil fatty acids, 0·0033. He finds that 1 per cent of free fatty acids lowers the coefficient as much as does 60 per cent of pure rape oil (acid-free).

These results have been confirmed by us on an independent machine, as we shall show later.

He has also shown, however, that pure neutral rape oil also possesses a lower coefficient than mineral, and concludes that "these results would suggest that the oiliness or lubricating efficiency of the unsaturated molecules of rape oil was really as great as that of the free fatty acid molecules, but that the acid molecules were much more active in their influence on the hydrocarbon molecules of the mineral oil."

These results, which show that 1 per cent of free fatty acids of rape oil added to a mineral oil are as effective in reducing the value of the frictional coefficient as in the addition to the mineral oil of 60 per cent of neutral rape, are striking confirmation of the above described principles and coming from a totally independent and unbiassed experimenter afford great support to our contention that it is not the glyceride but free fatty acids in a compounded oil which improves its lubricating value.

Through the courtesy of one of the largest engineering firms in the country we have been enabled to make a series of measurements in a large fraction testing machine, the results of which we here reproduce:—The test journal of the machine—which is of the Thurston type—is 3·8 in. diameter, giving approximately one foot peripheral per revolution. The length of the journal is 6½ in., and in all our experiments the load was 200 lb. per square inch. The machine is provided with a revolution counter and a drum upon which the reading of the arc is automatically traced. The driving motor was operated by a variable speed controller, and all care was taken to ensure steady and constant speeds. The journal and bearing were thoroughly cleaned before each test by washing with toluol, and finally rotated against velvet pads to remove all superficial dust and moisture. The experimental temperature was kept between 60° and 64° F.

The values of the frictional coefficients calculated from the curves obtained directly from the machine are given in Table IV.

By way of illustrating our point, four oils were chosen of identical viscosity and density but differing in composition (see Table IV.).

These results afford great support to the views exp above, and, coupled with our experience in practical cation, about to be mentioned, confirm our explanat the property of oiliness and open out a new and inva field in the manufacture of lubricating oil.

We should here mention that this principle of n lubricating oils by adding to mineral oils small qua of fatty acids or substances which lower the inte tension has been accepted by the Patent Offices civilised countries.

(To be continued).

## THE ULTIMATE MATTER.

By J. FREDERICK CORRIGAN.

(Concluded from p. 244).

*Prout's Hypothesis.*

The process of gathering together the fragmentary of knowledge, and piercing them together into a sci whole, apparently occupied philosophical minds for c century, and it is not until the nineteenth centur advanced nearly two decades that the old question *Prima materia* came up again.

In 1815-1816, W. Prout attempted to show that a atomic weights of the elements were exact multip the atomic weight of hydrogen, and thus "we may sider the πρώτη ὕλη of the ancients to be realis hydrogen. Thus, according to Prout, *all elements condensation products of hydrogen.* This view attr many followers, no doubt on account of its simplicity when it was eventually shown that the atomic weig the elements were *not* multiples of the atomic wei hydrogen, the theory died a natural death. Many to revive it by postulating the existence of a primal ele having half, a quarter, and even an eighth of the a weight of hydrogen; but it was obvious, however, this sub-division process could be carried on *ad infin* and so Prout's hypothesis has come to be regard untrue.

*The Periodic Law.*

Much evidence for a unitary theory of matter has gained from a close study of the periodic law. This which enables the elements to be classified, docketed pigeon-holed, has indeed proved a lode-star to the ch and modern philosopher, and like many other discov it had but a small beginning.

The first seed of the periodic law is generally sup to have been sown by J. W. Dobereiner, who durin years 1816-1829 noticed that the chemically si elements either possessed nearly the same atomic wei or else exhibited an almost constant difference arranged in sets of three. Thus, taking approxi atomic weights, we find that similar elements such as

| | At. wt. |
|---|---|
| Iron .. .. .. .. .. .. | 56 |
| Cobalt .. .. .. .. .. | 59 |
| Nickel.. .. .. .. .. .. | 59 |

have atomic weights closely related to one another, w in other sets of elements, a nearly constant differen noticed between the atomic weights:—

| | At. wt. | Diff. |
|---|---|---|
| Calcium .. .. .. .. .. | 40 | |
| | | 48 |
| Strontium .. .. .. .. .. | 88 | |
| | | 49 |
| Barium .. .. .. .. .. .. | 137 | |
| Chlorine .. .. .. .. .. | 35·5 | |
| | | 44·5 |
| Bromine .. .. .. .. .. | 80 | |
| | | 47 |
| Iodine .. .. .. .. .. .. | 127 | |

Dobereiner's Triads," as they were called, were, relegated to the background, and it was only in the subject of the periodicity of the elements ight up again by J. A. R. Newlands.

*Newlands' "Law of Octaves."*

ınds arranged the elements in ascending order of ɔmic weights, and he noticed that every eighth reproduced the properties of the first to a startling He also noticed that similar elements usually *l in the same columns. This phenomenon be* :he "Law of Octaves."

g approximate atomic weights of the elements ıt that time, and arranging them according to the ıctaves, we obtain the following tables :—

| | | | |
|---|---|---|---|
| ogen .. .. | 1 | Silicon .. .. .. | 28 |
| ım .. .. .. | 7 | Phosphorus . .. | 31 |
| lium .. .. | 9 | Sulphur .. .. .. | 32 |
| n .. .. .. | 11 | Chlorine .. .. .. | 35·5 |
| ɔn .. .. .. | 12 | Potassium .. .. | 39 |
| ıgen .. .. | 14 | Calcium .. .. .. | 40 |
| :en .. .. .. | 16 | Titanium .. .. | 48 |
| *ine* .. .. .. | 19 | Chromium .. : | 52 |
| ım .. .. .. | 23 | Manganese .. .. | 54 |
| ıesium .. .. | 24 | Iron.. .. .. .. | 56 |
| ıinium .. .. | 27 | | |

lands, however, had not a commanding address, must indeed have been no small mortification to ıen at the reading of his paper in 1866, one of our pedagogical conventionalists, whom even modern has not yet banished from her kingdom, inquired . *Newlands had ever examined the elements according* their initial letters!"

ough Newlands' law of octaves was not accepted, nciation had much influence in some minds, and a ars later D. G. Mendeleeff and L. Meyer brought ndependently, their respective periodic tables. It to be believed that both Mendeleeff's and Meyer's were constructed in complete ignorance of Newlands'

From these earlier classifications of the elements en evolved our modern Periodic Table, which is too ıown to *entail detailed description.*

felt—intuitively again—that the periodic table is et only an approximation to a general law, for there o or more absolute contradictions to the general :. In the case of the elements Argon and Potassium, um and Iodine, the atomic weights of Argon and um are both slightly higher than the atomic weights assium and Iodine respectively. But yet Potassium precede Argon, nor Iodine be placed before um, without breaking up the family relations of the its. A similar *case occurs between two of the rare* metals, but though several explanations have been of these discrepancies, a perfectly satisfactory one t to come.

ıt the riddle is, which is seemingly hidden only skin-eneath this placid and imperturbable array of num-ıas as yet baffled even the most brilliant thinkers. ıaturally associates with the phenomenon of the icity of the elements, the idea of complex aggre-of one elementary substance. Thus the arrange-of *particles of this primitive matter would resemble,* me respects, the homologous series of Organic stry, and like them would doubtless exhibit the menon of isomerism, although to a very much more ex degree.

| | $CH_4$ | $C_2H_6$ | $C_3H_8$ | $C_4H_{10}$ | $C_5H_{12}$ |
|---|---|---|---|---|---|
| | Methane | *Ethane* | *Propane* | *Butane* | *Pentane* |
| vt. | 16 | 32 | 44 | 58 | 72 |

of *interest to notice* that as many of the members mologous series of organic compounds are found, or are produced together, so also are closely related metals *always found to* be contaminated with each other in the natural state. Thus nickel is never found free from cobalt, lead is always found to contain a certain percentage of silver, and the members of the rare earth metals are found so intimately associated with each other that their separation is a matter of extreme difficulty.

*Evidence for the Unitary Theory of Matter obtained from a study of the phenomena of Radio-activity.*

examination of the groupings of the spectral lines, and also from a study of electric discharges in highly rarefied gases, but it is from an examination of the varied phenomena

Evidence for the unitary theory of matter, much too complex to be discussed in the space at our disposal, is obtained from a study of spectrum analysis, and an of radio-activity that the most abundant source of evidence is obtained. A merely superficial review, however, of this modern and infantile branch of science is all that can be attempted here.

*In passing, it is desirable to note that* Thomson had shown that atoms could be sub-divided to a certain extent, and from rarefied gases he obtained corpuscles, negatively charged with electricity, and possessing only about 1/2000 of the mass of the hydrogen atom. The most interesting point occurred when it was found that the corpuscles were absolutely identical irrespective of their source. Which fact recalls to us, rather nicely, the homœomeries of Anaxagoras.

In the element radium we witness an automatic degra*dation, or breaking-down process, which up to the present* has not been influenced in the slightest degree by any artificially imposed conditions. Radium, itself derived from Uranium, spontaneously undergoes changes into Radium Emanation (Nitron), Helium, and eventually passes into Lead—as far as can be ascertained. Thus we may represent the changes, excluding the transitory forms of matter more or less momentarily formed :—

URANIUM → IONIUM → RADIUM → . . . LEAD

*helium being formed* at each stage *of* the *degradation* process.

During the breaking down of radium, there are expelled $\alpha$-, $\beta$-, and $\gamma$-rays; the $\alpha$-rays being no less than a stream of positively charged particles of matter, whilst the $\beta$-rays coincide with Thomson's negatively charged corpuscles. The $\gamma$ rays, also, are almost identical with the Röntgen or $x$-rays. It is found that when an $\alpha$ particle is expelled from the radioactive atom, the atom looses 4 units in atomic weight and migrates to a group in the periodic *table two places to the left of its original position.* The $\beta$ particles not being more than 1/2000 of the mass of the hydrogen atom, causes on expulsion from the atoms, no change in atomic weight, but the element moves one or two places to the right in the groups of the periodic table, and thus becomes an "isotopic" element.

It is on considerations such as these that much of the modern thought with regard to the "ultimate matter" depends. Although the chain of evidence is being welded together link by link, and although, unlike the ancient *philosophers, we are able to point to definite facts on* which we rest our theories, our ideas are yet, and may continue to be for some time, scientific speculations.

In conclusion, having traced the "ultimate matter" idea throughout the ages, let us endeavour to obtain a parting view of the subject, and to see exactly how modern science stands with regard to this conception.

In the Beginning, when matter as we now know it was *non est*, there existed and extended throughout space, a form of latent or primitive matter, termed by Crookes "*The Protyle,*" and which, *of course, corresponds exactly* with the πρωτη ὕλη of the ancients. This potential matter in the course of time underwent a process akin to condensation, thus forming the different elements. Naturally, elements possessing the lowest atomic weights

have been conceived to have been formed first, and so on until finally elements with high atomic weights were formed. According to Crookes, the whole of this atomic evolutionary process has run on lines analogous to the "survival of the fittest" principle of the biological world, and elements not being fitted for existence have disappeared—*Extinct Elements*, whilst some others have only survived to a small degree, or have been formed by the breaking down of other elements—*Rarer Elements*. The *Common Elements* may be considered to be those elements whose environment and gradual process of upbuilding has most fitted them to undergo and to withstand the extreme variabilities of the Universe as a whole.

The extinct elements were, naturally, elements of high atomic weight, and which being unstable, decomposed, radio-actively or otherwise, into simpler forms of matter.

By the eighty odd elements which are known at the present day, three or more are more or less unstable, and are slowly but surely resolving themselves into simpler forms of matter. These elements are, of course, the radio-active elements. But are we in a position to definitely assert that radio-activity is the peculiar property of these few elements alone, and that the degradation process is confined solely to this handful of elements? May not other elements, indeed *all* the elements, be resolving themselves, although at an infinitely slow and immeasurable rate, into simpler forms of matter? It is possible to imagine that just as the elements were gradually built up from the protyle, so also they may be breaking up into simpler and simpler forms of matter and thus eventually resolving themselves once more into the protyle.

Thus, if it is true that the top of the atomic evolutionary curve has been reached, and that matter is again returning to its origin, a time may be conceived, although infinitely remote, when earth, sun, and stars have ceased to exist, and the whole Universe is void and empty, all elements having been resolved once more into the protyle—the *Ultimate Matter*.

## HIGH NEWSPAPER COSTS.

Successive Increases in Expenses of Production.

The Weekly Newspaper and Periodical Proprietors' Association, in a memorandum regarding the high cost of production, states:—

"Since 1914 the proprietors have had to meet a continued succession of increases in cost of production and distribution, and since the Armistice these increases have been intensified. The conditions under which they are at present labouring include:—

1. High price of paper, blocks, contributions, and illustrations.
2. Higher salaries and wages.
3. Altered conditions as to working hours, overtime, holidays, &c.
4. Higher railway and other transport rates.

"Before the war news print cost 1d. per pound, whereas it is now 6½d. per lb. and over, and there have already been 11 separate advances in printing charges, which have thereby been increased by 120 per cent to 200 per cent. On printing alone, for a 32-page weekly paper, with a circulation of 150,000 this means an increase in the cost of printing of between £5000 and £6000 per annum.

"As regards paper, to take a specific case, a publication using 20 tons of paper per week was spending in the purchase of paper before the war £186 per week—just under £10,000 per annum. The present cost of the supply for one week's issue for a paper of the same size at 6½d. per lb. is £1156, an advance of £970 per week, or £50,440 per annum.

"Many of the publications are, in fact, running at a substantial loss."

## WORK DONE BY THE FEDERATION OF BRITISH INDUS[T] COMMISSIONER SERVICE.

Summary of Sir Charles Mandleberg's Rep

In his report Sir Charles Mandleberg defines the pr of the Commissioner Service of the Federation of I Industries as the appointment of representatives of I industry on the spot in all the principal markets world. The Commissioners are intended as Ambas of Industry to watch over and safeguard the inter British manufacturers and to promote in every wa sible the consumption of articles of British manufac the market for which they are responsible. Their fun in detail may be summarised as follows:—

1. To act as a centre for collecting and classifyi formation, particularly with regard to:—(*a*) I ments and methods of trade; (*b*) Status of tra (*c*) Trade requirements; (*d*) Foreign competi
2. To recommend suitable selling agents when req by Members.
3. To protect the interests of Members and act gen for them in emergencies.
4. To have a panel of legal advisers.
5. To have a panel of interpreters.
6. To form a library, containing translations c portant documents, such as Customs regula &c.
7. To engage rooms for the deposit and displ samples.
8. To act in co-operation with representatives of Government in the interests of Members.
9. To appoint a local board of prominent business in sympathy with British aims, to advise the missioner generally.
10. To display and distribute Members' catalogues.
11. To constitute their Offices a meeting place a formation bureau for Members and their agen
12. To keep a special watch on trade statistics kinds, and refer particulars of them to the Office with their observations.

*One Year's Growth.*—The Commissioner Servic inaugurated nearly a year ago, when Major Kennard the F.B.I. Commissionership for the Near East headquarters at Athens. One important result o appointment was the successful exhibition of British factures held in the Zappeion Palace at Athens d October and November, 1919. The next Commiss ship to be established was at Madrid, where the Fede took over the Bureau set up by the Ministry of Inf tion during the war. This office was opened in 1919, with Col. C. Thoroton, C.M.G., as Commiss The visit to Great Britain of the influential Bra Mission, which toured the industrial centres of this co in the summer of 1919, under the auspices of the F offered a unique opportunity for the establishment Commissioner in Rio de Janeiro, with supervision fo time being over the whole of the East Coast of America. Mr. P. J. McKellen was appointed to this and left for Brazil with the Brazilian Mission at th of September. At about the same time an East I Commissioner, in the person of Mr. G. O. Blacker, appointed to cover the Netherlands East Indies, S Settlements, Siam, and French Indo-China, with o at Singapore. Mr. Blacker took up his duties th October, 1919, and his wide knowledge of the East I market has enabled him already to carry out work of siderable service to manufacturers in this country. most recent appoinment to be made was Mr. Mor Villiers as F.B.I. Commissioner for Scandinavi November last. Mr. Montagu Villiers, after maki preliminary tour of the three Scandinavian countries, w he knows intimately, has just opened his offic Copenhagen. Further, the Federation has already st

into operation its policy of establishing sub-Com- nerships dependent upon the Commissionership in ferent markets. Those already set up are Capt G. erbatch as sub-Commissioner for Greece, and Capt. .efontaine as sub-Commissioner for Turkey, both dent upon the Near Eastern Commissioner, and Mr. aroton, sub-Commissioner in Algiers, covering the Coast of Africa under the F.B.I. Madrid office. In on to these permanent offices, the peculiar conditions in South Africa decided the Federation on a some- different course of action with regard to this market, Ir. C. W. F. Harrison was despatched in February year with instructions to tour the Dominion and ent territories and to make a general report on the ion, suggesting the best means of representation for ederation to adopt. Such, in brief, is the history of ommissioner Service up to February, 1920. It is the y of the Federation to keep these Commissioners in losest touch with the trade developments and the of the F.B.I. at home. Arrangements are constantly for them to return to this country for short visits, every opportunity is given them to interview members ested in their markets.

ork of the Commissioner Service.—The work which Federation Commissioners are engaged to carrying lls roughly under three main heads:—(1) Propaganda, ntelligence, (3) Influence.

As regards the first point, in some ways the greatest of the Commissioner Service lies in its effect as a prehensive advertisement for British goods, a tangible f to the Overseas buyer of the desire of the United dom manufacturers to sell him their products. To ort Commissioners in their work special literature has printed in fifteen different languages, briefly describing scope and advantages of the Federation. The nisation of such exhibitions as that at Athens already red to is another instance of the value of the service he way of collective propaganda for industry. In tion to propaganda of such a nature, the Commis- ers have done a great deal of work in advising in- lual manufacturers in the best methods of advertisement eir areas and in displaying and distributing their trade ature and catalogues,

Almost as important a part of the Commissioners' k has been and will continue to be the collection of all ls of trade information likely to bring about and itate commerce between manufacturers in this country buyers in the markets overseas. Included under this ding are such varied activities as the compilation of orts on demands for particular goods, reports on foreign petition, on credit and banking facilities, status reports, recommendation of suitable agents, and the collection definite inquiries on different classes of goods manu- ured in this country. The last two of these, namely, ommendation of agencies and the collection of trade iries, have come into particular prominence owing to breakdown of old trade channels, agency agreements, , as a result of the war.

. Ambassadors of British Trade.—This phase of the nmissioners' work is perhaps the most important of the e. The Federation has selected Commissioners with view to their being able to justify the designation of bassadors of British industry, Consequently, only men the very best type have been selected, with the result t the British manufacturer now has, in those markets ered, representatives capable of expressing with con- nce and dignity his views and wishes to the Govern- nt of the countries where they are stationed, and to er official and unofficial bodies whose action from time time may run contrary to the interests of the British orter. It is hoped that in the near future some at st of the Commissionerships will be made self-sup- ting, and as this result is achieved it will be possible to end the service to other markets until British manu- turers have a complete network of first-class repre- sentatives safeguarding their interests and pushing British commerce throughout the whole world.

Commissioners and representatives have been appointed to the principal countries abroad. Also a large number of individuals abroad, official and unofficial, from patriotic motives, have on many occasions furnished, and are furnishing, valuable information to the head office of the Federation of British Industries.

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, May 13, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read:—

"*Demonstration of the Apparent 'Growth' of Plants (and of Inanimate Materials) and of their Apparent 'Contractility.'*" By A. D. Waller, F.R.S.

In Sir J. C. Bose's original demonstration an amputated leaf was fixed up in connection with a crescograph, at a magnification stated to be $\times 10^7$, and the indicator was shown to be moving in a direction and at a speed that were stated as representing growth of the petiole. Alternating currents were now sent through the leaf, causing a sudden reversal of the movement of the in- dicator; *e.g.*, in the demonstration that I witnessed at the Royal Society of Medicine, the indicator (a spot of re- flected light) moved to the right at what I judged to be something like 1 metre per sec. in the direction of elonga- tion (by growth ?), and flew off scale in the opposite direc- tion, at least ten times as fast, as soon as the buzz of the exciting coil was heard ("degrowth").

The demonstration was, in my opinion, wholly illusory. The movement to the right (indicating an elongation of petiole = 0·1 m. per sec.) was indeed consistent with "growth," although its rate was surprisingly high under the conditions of experiment. The elongation might, however, have been due to, or modified by, many acci- dental variations of conditions—heat, moisture, handling of plant during preparation, &c., and was precisely similar to the gradual elongation that takes place in a damp fiddle- string under similar conditions.

The second part of the experiment, when the "excited" plant shortened and caused the indicator to fly off to the left, was, in my eyes, the obvious and conclusive proof of fallacy. The fact clearly belonged to the familiar pheno- mena of heat contraction aroused by electrical currents in all kinds of (doubly refracting) moist conductors, whether living or dead, to the study of which our attention was drawn by Englemann in his Croonian Lecture of 1895. They are demonstrable with a low-power crescograph ($\times 10^3$), and play a part in masking or simulating physio- logical changes when a high power ($\times 10^7$) is employed.

I hope, if time allows, to demonstrate the usual effects by two experiments—(*a*) on an amputated living plant; (*b*) on a damp fiddle-string.

"*On the 'Renal Portal' System (Renal Venous Mesh work) and Kidney Excretion in Vertebrata.*" By W. F. N Woodland.

The first three parts of this Memoir contain, in the first place, proof that the assumption, commonly made in physiological literature, that the venous blood "supplied" to the kidneys of lower vertebrata mixes with the arterial blood, and traverses the system of channels known in mammals as the intertubular plexus, is erroneous— the renal afferent vein-blood does not supply the kidney tubules. The renal artery-blood traverse the inter-tubular plexus proper, and the renal afferent vein-blood a system

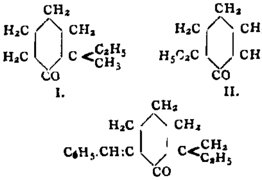
of wide sinusoids (renal venous meshwork), which has no connexion with the intertublar plexus, save that the latter opens into the former where the venous blood flows into the renal afferent veins.

In the second place, much experimental and other evidence is provided to prove that the "renal portal" system is devoid of function so far as kidney secretion is concerned. Evidence is also adduced to show that the urine is solely secreted by the renal tubules, the glomeruli taking no part. The glomeruli (as will be explained in the forthcoming Part IV.) are solely to be regarded as retia mirabilia and function as such. This is the tubule-complete theory of kidney secretion.

## CHEMICAL NOTICES FROM FOREIGN SOURCES.

*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. clxx., No. 17, April 26, 1920.

CONSTITUTION OF METHYLETHYLCYCLOHEXANONE PREPARED BY THE ETHYLATION OF α-METHYLCYCLOHEXANONE. A. Haller and R. Cornubert.—Methylethylcyclohexanone prepared by A. Haller has been submitted to the same tests as its interior homologue, dimethylcyclohexanone (Comptes Rendus, 1920, clxx., 700). It has failed to show that it also possessed an asymmetric structure, and evidence goes to show that it corresponds to Formula I. and not Formula II., as was at first supposed.



I. II. III.

The authors arrived at this conclusion by condensing the ketone with a molecule of benzaldehyde in the presence of hydrochloric acid, thus obtaining the benzidene derivative (Formula III.).

ON THE SALTS OF NITROSOPHENYLHYDROXYLAMINE (CUPFERRON) URANOUS SALT.—V. Auger.—The use of the ammonium salt of nitrosophenylhydroxylamine for precipitating copper and iron in acid solution has been proposed by O. Baudisch (*Chem. Zeit.*, 1909, xxxiii., 1298). It has also been used to precipitate titanium, zirconium, thorium, and vanadium, besides which it has been stated that it has given precipitates with silver, mercury, tin, and bismuth. The author has undertaken a systematic study of the salts of cupferron. He has found that cupferron precipitates all the metallic salts with the exception of the alkalis in neutral solution, but the salts formed can be divided into two classes; the simple salts, which are decomposed by dilute acids and are insoluble in chloroform, and the complex salts which are soluble in chloroform or other neutral solvents and resist the action of strong acids. He has prepared the uranous salt, which is interesting, for uranium is not precipitated by cupferron, according to W. A. Turner, who employs this reagent to separate uranium from vanadium; but if the uranyl salt is converted into the uranous salt by reduction with zinc in either sulphuric or hydrochloric acid solution, the cupferron precipitates the uranium completely in acid solution in the form of brown flakes, soluble in chloroform or neutral solvents, and crystallising by evaporation in small brown prisms. Ignited in air it has given 35 per cent $U_3O_8$; calculated gives $(C_6H_5N_2O_2)_4U$ 35·7 per cent.

Vol clxx., No. 18, May 3, 1920.

THE CATALYTIC ACTION OF CARBON ON THE DECOMPOSITION OF FATTY ACIDS.—J. B. Senderens and Aboulenc.—The results of researches on the action of carbon, in the form of washed and dried animal charcoal on certain fatty acids, are given. If the lower members of the fatty series are heated they do not commence to decompose until a temperature of 460° is attained, but if the vapours of the acids are allowed to pass over heated animal charcoal then an evolution of gas occurs at 360—380°. A table is given which gives the composition of the evolved gas for different acids. The liquids which were collected constituted in the main part acid which has escaped decomposition, together with a notable proportion of water and traces of ketones and aldehydes.

## NOTES.

CATALOGUES FOR ASIA MINOR.—Commercial Secretary to the British High Commissioner at Constantinople (Captain C. H. Courthope Munro), has reported to the Department that arrangements have been made by Captain Perring, the High Commissioner's Representative at Samsoun, with the local manager of the Imperial Ottoman Bank, for British trade catalogues and literature to be exhibited in the offices of the Bank, where they will be available for reference by the trading communities. It is understood that similar arrangements are also in course of negotiation at other centres in Asia Minor. United Kingdom firms desirous of having their trade literature placed on view at the Bank are invited to forward copies of their catalogues, &c., direct to the British Control Officer, Samsoun, Asia Minor. Catalogues should preferably be printed in either the French, Greek, or Turkish languages. Parcel postage rates are as follows:—Not over 3 lbs., 1s.; over 3 lbs. but not over 7 lbs., 1s. 4d. over 7 lbs. but not over 11 lbs., 1s. 8d.

AGENCIES IN HOLLAND.—(From H.M. Commercial Secretary at The Hague). – There can be no doubt that British trade in Holland has in the past suffered in comparison to the progress made by Germany. This can of course be in a great measure attributed to the geographical position of Holland and to the similarity of the Dutch and German languages, rendering it possible for a German firm to "cover" Holland with their travellers almost as if it were a German province. The consequence was that the smallest buyers in the most out of the way towns were regularly visited by German travellers, while they were in many cases entirely ignorant that the goods that they dealt in were manufactured in the United Kingdom at all. Furthermore, German goods were made to suit the market and put up in packages with Dutch lettering and where necessary Dutch directions for use, details which were ordinarily ignored by British firms. In many lines, too business is lost to the United Kingdom owing to the lack of stocks in this country. Take for instance steel and hemp hawsers and ships paint: a tug-boat may break a tow-line or a ship may need a coat of paint: in many instances British hawsers or paint could only be obtained by ordering from the United Kingdom, and the order is therefore filled by a perhaps inferior article of German make simply because it is available for delivery from stock. Many British firms with business relations of old standing with Holland are not represented here, but content themselves with sending a representative once or twice a year to book orders. The best comment on this

ply actually given by a local firm to one of these lers who was making his half yearly round to book s:—"Sir, the chances against my wanting something on the day of your visit are something like 180 to 1." sentation therefore can, I think, be summarised in llowing scale, arranged in order of merit:—

Branch office in Holland with or without stocks according to circumstances.

Resident British representative.

Agency entrusted to British merchant firm established in Holland.

Agency entrusted to Dutch firm.

No local representation: traveller making periodical visits.

os. 1 and 2 are of course beyond the means of many, but the suggestion has been made that several ufacturers of cognate but non competing articles t establish a selling agency in common on one or of these bases. It is considered above all important no British firm should appoint a local agent without sending a responible member of the firm to examine conditions, ascertain the type of article most in use, make careful enquiries as to the capacity of the agent ver the district entrusted to him and as to other and ibly competing agencies held. Incidentally it would be not to ignore the question of a language thoroughly rstood by both parties. Cases have come to my e of serious difficulties and misunderstandings arising ly owing to the fact that the Dutch agent, while prong a good knowledge of English and possibly speakt moderately, could not express himself intelligibly in etters to his British principals nor gather the correct ning of their communications. As regards the class gent coming under headings Nos. 3 and 4, *i.e.* whether ng on own account or working on a commission s, much depends on the nature of the goods and the es of the principals. On the whole I am inclined to ur a commission agent, provided he is energetic, ciently in a position to cover his district, and helped dvertisement. The whole question of advertisement Holland is one which would repay further study by rts, as the conditions, both material and psychological, very different to those obtaining in the United Kingdom, the opportunities are large, the art of advertisement not having by any means reached the standard of at Britain and America.

MEDICAL SUPPLIES FOR BUCAREST.—The Commercial retary to His Majesty's Legation at Bucarest has rted to the Department of Overseas Trade that the ntier Guards of Roumania desire offers from British ses for medical supplies, instruments, &c. As the ount of money at the disposal of the Medical staff is ted the quantities to be purchased are not mentioned, bese will depend upon the prices quoted. Offers should addressed, preferably in the French language, to:—nsieur le Commandant I Cerna, Corpul Graniceri, levard Bratianu (Colt cu Batiste), Bucarest. Articles uired are:—Acid boric, Acid carbolic pure, Antipyrin, irin, Quinine sulphate, Dermatol, Iodine, Iodide of ash, Permanganate of potash, Protargol, Sulphate of a, Bismuth salts, Vaseline. Instruments:—Graduated nges and needles, Platinum needles, Surgeons knives h straight metal handles, Probes, General Surgical ruments. Bandaging Material:—Cotton-wool, Gauze, bber sheeting, Bandages.

UNIVERSITIES AND THE INDUSTRIAL WORKERS.—Speakon the subject of Universities and the Industrial rkers, at the Garden Party given on Saturday, the h inst., by the Bishop of Birmingham to the members he Birmingham Branch of the Industrial League and uncil, of which he is the President, Dr. Grant Robertson, ncipal of the Birmingham University, said—They of University were very much concerned with the indusl future of this country, and were doing all they could contribute to the commercial prosperity of the nation. It was most important that there should be a better understanding between employers and employed, but the one essential condition of anything like progress was a more widespread education. It was the duty of the University to do what they could in that direction, and furthermore, to take part in a movement which had become very important during the last few years, and was going to be more important in the future—adult education. A University in a great industrial centre had not only a duty towards its own students who came for the purpose of degrees, but towards general education, a better understanding of the great problems of economics, history, politics, and institutions upon which our progress and prosperity absolutely depended. The people of this country had its future in their own hands, the one condition being that they should understand and be trained to understand what the problems really were. In affording this grasp of economic history and ideals, past and present, the Universities ought to contribute all in their power, because they came in an impartial capacity, having no party to serve. They were not there to further the interests of any one party, or any one class; they were there only in the service of the community. They in the Universities regarded themselves as there only for the highest education of the whole nation, and they looked to the nation to support them financially and otherwise, so that they might be able to perform this purpose. Dr. Robertson passed on to a reference to the movement whereby day courses were started at the University for workpeople—the beginning of a very great movement. The whole idea was that they did not want to get people who were tired out coming to them for instruction, and by arrangement between employers and the trade unions they now had about thirty students who did two days each week at the University. That number could be greatly increased. It all depended on the employers and the unions. The University, recognising it as the start of a very great movement, wanted to see it grow.

SOUTH AFRICAN EXHIBITIONS.—Numerous agricultural shows are to be held during the year at various centres in South Africa, at which agricultural machinery and implements, tractors, &c., are to be exhibited. In addition, motor vehicles are, in some cases, to be exhibited. Particulars of the exhibitions may be obtained from the Department of Overseas Trade, 35, Old Queen Street, S.W. 1. The attention of British firms is specially invited to these exhibitions, as information to hand from H.M. Trade Commissioner at Capetown indicates that a good deal of space has already been booked for the exhibition of American manufactures.

DUTCH EXHIBITION OF TRANSPORT VEHICLES, MATERIALS, &c.—In September next an exhibition will be held at the Hague of motor lorries, road rollers, concrete mills, and road materials on the occasion of the meeting of the First Netherlands Congress. The object of this Exhibition will be to provide a representation as full and complete as possible of the progress made in recent years in the means of transport and in the construction of roads. The Exhibition will take place under the auspices of the First Netherlands Roads Congress, and the offices will be at 18, Park Street, The Hague.

LAUSANNE SWISS FAIR.—Further particulars of the forthcoming Swiss Agricultural and Alimentary Industries Fair to be held at Lausanne have now been received by the Department of Overseas Trade. The Fair will be held from September 11 to 26, participation being confined to Swiss firms. The daily hours of opening will be 8 a.m. to 6 p.m., the public being allowed in from 2 p.m. to 6 p.m., and on Saturdays and Sundays. British buyers may secure a personal card, available for three days, by application to "Direction du Comptoir Suisse," 1, Escalier de la Grotte, Lausanne, not less than a fortnight before the Fair commences. There are thirteen exhibiting groups in food production and twenty-three in agriculture, covering every industry connected with the two sciences.

## MEETINGS FOR THE WEEK.

*Monday, May* 31.

Royal Society of Arts, 4.30. (Indian Section). "The Improvement of Crop Production in India," by Albert Howard.

*Tuesday, June* 1.

Royal Institution, 3. "The Evolution of Large Bridge Construction," by Major C. E. Inglis.

*Wednesday, June* 2.

Society of Public Analysts, 8. "Perchlorate Method for Potash," by R. Leitch Morris. "Estimation of Nitroglycerin," by H. Droop Richmond. "Apparatus for Evolution Methods of Analysis" and "An Improved Form of U-tube," by E. R. Dovey.

*Thursday, June* 3.

Royal Society, 4.30. (The Bakerian Lecture). "The Nuclear Constitution of the Atom," by Sir Ernest Rutherford.

Royal Institution, 3. "Dreams—with Special Reference to Psycho-Analysis," by William Archer.

Chemical Society, 8.

*Friday, June* 4.

Royal Institution, 9. "Science and Poetry," by Sir Ronald Ross.

Royal Society of Arts, 4.30. (Indian and Colonial Section). "The Oil Resources of the British Empire," by Prof. Sir John Cadman.

*Saturday, June* 5.

Royal Institution, 3. "The Theory of Quanta," by Prof. J. H. Jeans.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HE CHEMICAL NEWS.

VOL. CXX., No. 3138.

# E CONSTITUTION AND STRUCTURE OF AN ATOM OF MANGANESE.

By HAWKSWORTH COLLINS.

: *following investigation with regard to manganese,* des demonstrating the structure of this and several :r elements, unifies three generalisations, viz., the Odd Even Rule (CHEMICAL NEWS, Oct. 11, 1907, and /. 14, 1913), the Interrelationship of the Elements and Periodic Observation, and proves them all to be due he same cause.

s it is necessary to give here the whole of the evidence :ing on the structure of Mn some repetition of portions ormer papers cannot be avoided.

he only experimental data employed are those given Table III. of the preceding paper (CHEMICAL NEWS, o, cxx., 169). The elements there given are not chosen trarily, but they are selected because they fulfil a ain condition, viz., that the sum of their atomic ghts in pairs approximates to the atomic weight of Mn; since it was proved in the CHEMICAL NEWS (Nov. 28, )) that the atomic weights are whole numbers, it may said that they are selected because the sum of their nic weights in pairs is always exactly equal to the wt. of Mn.

ı Table I. these elements are placed in the order of *nding atomic weight. The second column gives the* imum valencies, the fourth gives the at. wts., the n gives the atomic weights split into parts, the seventh s the number of parts into which each at. wt. is split and the third, fifth, and eight columns, which corre nd *exactly*, give *remarks on the second, fourth*, and nth columns respectively.

TABLE I.

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | even | 4 | even | 3+1 | 2 | even |
| 1 | odd | 7 | odd | 7 | 1 | odd |
| 3 | odd | 11 | odd | 7+(1+3) | 3 | odd |
| 2 | even | 16 | even | 7+1+(3+1)+(3+1) | 6 | even |
| o | even | 20 | even | 7+1+(3+1)+(3+1)+(3+1) | 8 | even |
| 1 | odd | 23 | odd | 23 | 1 | odd |
| 2 | even | 24 | even | 23+1 | 2 | even |
| 3 | odd | 27 | odd | 23+(1+3) | 3 | odd |
| 4 | even | 28 | even | 23+1+(3+1) | 4 | even |
| 5 | odd | 31 | odd | 23+(1+3)+(1+3) | 5 | odd |
| 6 | even | 32 | even | 23+1+(3+1)+(3+1) | 6 | even |
| 7 | odd | 35 | odd | 23+(1+3)+(1+3)+(1+3) | 7 | odd |
| 1 | odd | 39 | odd | 39 | 1 | odd |
| 4 | even | 44 | even | 39+1+(3+1) | 4 | even |
| 6 | even | 48 | even | 39+1+(3+1)+(3+1) | 6 | even |
| 5 | odd | 51 | odd | 39+1+7+(1+3) | 5 | odd |
| 7 | odd | 55 | odd | 39+1+7+(1+3)+(1+3) | 7 | odd |

aree sets of coincidences with regard to these experital data, when arranged in a certain manner, were n in the CHEMICAL NEWS of April 9, 1920.

ere, when they are arranged in a different way, no less seven other sets of coincidences become evident :—

) When the at. wt. of an element approximates to an integer the valency is odd, and when the at. wt. oximates to an even integer the valency is even. re are no exceptions.

(2) The atomic weight of each element can be split up in a uniform manner into as many portions, 1, 3, 7, 23, and 39, as the element has valencies with two exceptions.

(3) These portions are all represented by odd numbers.

(4) The portions can always be arranged so that the unit masses are placed alternately in the second, fourth, and sixth positions, considering the position on the extreme left as the first.

(5) The non-metallic elements always contain one or more portions (1+3), whilst the metallic elements do not contain this portion.

(6) Electro-positive valences are differentiated from electro-negative valences by the following rule:—An electro-positive force emanates from each of the portions, 1, 3, 7, 23, 39, except when an element contains one or more portions (1+3), in which cases a pair of electro-positive forces emanate from each portion (1+3) and electro-negative forces emanate from each of the remaining portions.

(7) If helium (1+3) with its two electro-positive forces could be thrown off from the triad boron the monad *lithium would be left. If two atoms of helium could be* thrown off from the pentad phosphorus the monad sodium would be left. And if the same could be done with the hexad sulphur the dyad magnesium would be left, and so on in several cases. In general, if helium with its two electro-positive forces could be thrown off from any non-metallic element a metallic (or more metallic) element would be left, possessing valences less by two than the *original.*

*Proof that* (1) *is not the Result of Accident.*—The probability that (1) is the result of accident is $1 : 2^{17} = 1 : 128{,}000$.

*Proof that* (2) *is not the Result of Accident.*—If the at. wt. of Mn had been greater or less by unity, *i.e.*, if it had been 54 or 56, it would have been impossible to split it up into 7 portions of masses 1, 3, 7, 23, or 39. And exactly similar remarks apply to all 17 cases, so the probability that the nearest whole number to the at. wt. of any one of these 17 elements could be *split up in this manner* is at least 1 : 2, and the probability that the same could be done in the 17 cases is $1 : 2^{17}$, with two exceptions $1 : 2^{13} = 1 : 8000$.

The probability that (3) is the result of chance is $1 : 2^{4}$.

*Proof that* (4) *is not the Result of Chance.*—The extraordinary nature of this coincidence can be most conveniently demonstrated by examples in the first instance.

If the at. wt. of Mn had approximated to any of the numbers 52, 53, 54, 56, 57, 58 *instead of to* 55 *it would* have been impossible to split it up in the required manner. The nearest approach to it is 57 = 1+39+1+7+1+7+1; but this is not in accordance with the arrangement in the table, since unit mass comes in the first position.

If the at. wt. of Cl had been nearer to any of the numbers 32, 33, 34, 36, 37, 38 than to 35, it would have been impossible to split it up in the manner r.quired.

If the at. wt. of S had approximated to any of the numbers 29, 30, 31, 33, 34, 35 instead of to 32, it would have been impossible to split it up in the required manner.

Exactly similar remarks apply to all the 17 elements, except to O and Ne (*vide* CHEMICAL NEWS, Dec. 26, 1919).

So that the probability that this is the result of accident is something like—

$$1 : 7^{17 - \frac{2 \times 7}{6}} = \text{one : millions.}$$

*Proof that* (5) *is not Due to Chance.*—The probability that (5) is the result of accident is $1 : 2^{17} = 1 : 128{,}000$.

*Proof that* (6) *is not Due to Chance.*—If this had been a simple coincidence like (1) the probability that it is not the result of accident would be 128,000 : 1; but as it is a very complicated coincidence the probability against its being due to accident is enormously greater.

*The Seventh Coincidence.*—This discovery was sent to

several leading chemists in 1906, and was published in the CHEMICAL NEWS, Oct. 11, 1907, many years before the radio active discoveries of exactly similar nature were made. Therefore the latter are experimental proofs that the former deductions are true.

All these ten coincidences are due to one CAUSE, which is as follows:—A single chemical force emanates from elements or portions (of elements), of which the masses are 1, 3, 7, 23, and 39, taking the mass of an atom of hydrogen as unity.

As these five masses are all represented by odd numbers, and since the sum of an odd number of odd numbers is odd, and the sum of an even number of odd numbers is even, therefore the elements which have odd atomic weight must in general have odd valency, and those which have even atomic weight must have even valency.

The reason why Mn is observed to be closely related to the other 16 elements in the table is evident by arranging the portions of the element in different ways as follow:—

$$3+1+39+1+ \vdots\ 7+1+3 = \overset{IV}{Sc}\ \ \overset{III}{B}$$

$$3+1+3+1+39+1\ \vdots +7 = \overset{VI}{Ti}\ \ \overset{I}{Li}$$

$$3+1\ \vdots +3+1+39+1+7 = \overset{II}{He}\ \ \overset{V}{V}$$

nd since $39+7 = 23+23$

$$23\ \vdots +1+23+1+3+1+3 = \overset{I}{Na}\ \ \overset{VI}{S}$$

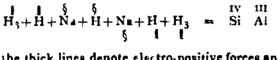
$$23+1\ \vdots +23+1+3+1+3 = \overset{II}{Mg}\ \ \overset{V}{P}$$

$$23+1+3\ \vdots +1+23+1+3 = \overset{III}{Al}\ \ \overset{IV}{Si}$$

nd since $23 = 20+3$

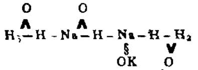
$$20\ \vdots +3+1+3+1+3+1+23 = \overset{O}{Ne}\ \ \overset{VII}{Cl}$$

It is evident from mineralogy that Mn is found in its ltimate matrix especially associated with Si and Al, and its chemical properties it sometimes resembles Si, metimes Al, and at other times it acts like the two gether. For these and all foregoing reasons the contitution and structure of an atom of manganese is actically certain to be—

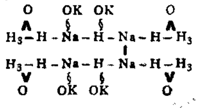


here the thick lines denote electro-positive forces and the es represented by the sign § electro-negative forces.

The molecule $KMnO_4$ would then be—



d $2K_2MnO_4$—



In the Periodic Table the elements are arranged in rows ascending order of atomic weight, and in columns according to their maximum valences; so that evident that the periodic observation is dependent some connection which exists between the two proper atomic weight and maximum valency; and it has shown that the Odd and Even Rule and the Interrelat ship of the Elements are concerned solely with the two properties; and the cause which has produced t two latter observations has been proved to be a cer definite connection between atomic weight and max'r valency; therefore the Periodic Observation is due to same cause as are the other two observations.

## RESEARCHES ON THE METHODS OF MANUFACTURE OF BARYTA FROM SULPH OF BARYTA.

NUMEROUS processes have been invented or propose obtain baryta directly from barium sulphide. Messrs Terris and K. Bruckner describe their researches in *Zeit. Elektrochemie* for January. The reaction seem be—

$$2BaS + 2H_2O = Ba(OH)_2 + Ba(SH)_2.$$

Sulphide of barium. Water. Baryta. Hydrosulphate of barium.

Thus it seems easy to obtain baryta. In reality reaction is incomplete. Moreover a double salt is forr and the baryta produced always retains hydrosulph which it is impossible completely to remove, whatever means employed. The phenomenon is complex and results obtained vary with temperature, concentration, numerous other factors. The conclusion of the author that no known process gives the results claimed. Fina that a process based upon this reaction is not industrial *Génie Civil*, April 18, 1920.

## A NEW METHOD OF MEASURING TRANSITION POINTS.

By ANDREW McKEOWN.

The Donald Currie Laboratories, Queen's University, Belfast.

THIS method was suggested by the fact that water of cr tallisation enters into the composition of the majority compounds which possess transition temperatures. T liberation of this water from the molecule at the transiti point is essential to the success of the method.

First, consider the case of a salt of a weak acid and strong base which possesses water of crystallisation. the transition point of the hydrate the water which is sp off dissolves some of the salt, and since the salt is hyd lysed in solution, it should give an alkaline reactic Hence the transition point could be observed by means an indicator.

This was tested by Miss E. M. McV. Blair and mys for a series of substances, as follows:—The salt hydra *e.g.*, sodium acetate, was mixed with a little solid phen phthalein (or solution of phenol-phthalein in absolute alc hol) in a test-tube or beaker, all apparatus and chemic being perfectly free from moisture. The mixture w heated, with constant stirring in a water-bath. The te perature of the bath was never allowed to rise much abo that of the contents of the beaker, superheating of t outer layer of sodium acetate being thus avoided. Wh the temperature of the sodium acetate hydrate had reach about 58° C., the acetate assumed a distinct pink colo showing that the transition was taking place. In so cases a faint pink coloration was noted during the heatin due to the vapour pressure of the hydrate, but this is eas

nguished from the abrupt deep coloration at the tran-n point. Results for a few hydrates are here given :—

| | I. | II. | III. |
|---|---|---|---|
| odium acetate .. | 58° C. | 58° C. | 57·5° C. |
| odium phosphate | 35·5° C. | 35° C. | 35·2° C. |
| orax .. .. .. .. | 60° C. | 60·5° C. | 60·3° C. |

gain, in the case of the hydrate of the salt of a strong and a weak base, the solution of the salt in its water rystallisation is also hydrolysed to some extent, and ws an acid reaction. Therefore, with a proper indi-r, change of colour shows when the transition temper-e is reached. This was verified in the case of potassium n, methyl orange in alcoholic solution being used as cator. A transition point at 42° C. was noted.

or the salt of a strong acid and strong base, hydrolysis not take place. In this case, we mixed the salt rate with a small quantity of dry magnesium oxide solid phenolphthalein. The water liberated at the isition temperature forms $Mg(OH)_2$ with the magnesium le, and the alkalinity of this hydroxide causes the nge of colour of the indicator which denotes transition. Under these conditions, sodium bromide dihydrate gave lear transition point at 50° C., while sodium sulphate ahydrate gave two transition points shown by a gradual k coloration between 20° and 25° C., and a much deeper nation at 32° C.

Enough has been said to show that the method, within imitations, gives fairly accurate values for the transi-i points of all classes of substances for which it is licable. It will be seen that the only essential condi-for its use is the liberation of water at the transition it to be determined, and hence a very large number of stances are brought within its reach. It should be ed, however, that a very great specific vapour pressure etrimental to the obtaining of a sharp transition point. example, sodium carbonate decahydrate efflоresces ngly on exposure to air, and it was found impossible letermine its transition temperature by this method.

## SPECIAL REPORTS ON THE MINERAL RESOURCES OF GREAT BRITAIN

FRACTORY MATERIALS—GANISTER AND SILICA ROCK. ND FOR OPEN-HEARTH STEEL FURNACES—DOLOMITE

E Ministry of Agriculture and Fisheries desire to give ice of the publication of a second edition of the sixth ume of the *Special Reports on the Mineral Resources* Great Britain, which have been prepared by the ector of the Geological Survey in response to numerous quiries that have arisen through the conditions brought out by the late war. Price 7s. 6d. net.

This edition is in the main a reprint of the first edition. e greater part of the volume is concerned with the rces of ganister and silica-rocks used in the manufac-e of silica-bricks, or suitable for that purpose. The currences of these rocks are described in detail, and an count is given of their geological relationships, with ef notes on their petrological characters and the methods ployed in their treatment for the market. The quarries d mines are described under the names of the firms erating them, arranged according to counties or grouped districts of which the following are the more important :— rkshire; the country around Durham, including North eveland; Derbyshire; parts of Cheshire and North affordshire; Lancashire; Cumberland; certain Mid d Counties; North and South Wales; and Scotland. Chapter XII., the sands and clays, which are found in ckets in the Peak district, are described. Chapter XIII. als briefly with the sands employed for open-hearth el furnaces. Chapter XIV. is devoted to an account of the distribution and characters of dolomitic rocks available for the manufacture of basic steel.

Copies may be obtained through any bookseller from the Director-General, Ordnance Survey Office, Southampton.

## THE THEORY AND PRACTICE OF LUBRICATION: THE "GERM" PROCESS.*

By HENRY M. WELLS and JAMES E. SOUTHCOMBE, M.Sc.

(Continued from p. 260).

We should add a word here with regard to the possibilities of corrosion.

As will be observed from Table IV., all compounded oils which have been and are in daily use for years contain notable amounts of free fatty acidity, yet one rarely hears of any active corrosion.

TABLE IV.

| | A. | B | C | D |
|---|---|---|---|---|
| Viscosity at 60° F. (second Redwood) .. .. .. .. | 973 | 973 | 980 | 970 |
| Sp. gr. at 60° F. .. .. .. | 0·909 | 0·903 | 0·908 | 0·907 |
| Total acidity, calculated as oleic acid (per cent) .. | Nil | 1·9 | 0·3 | 0·9 |
| Mean temperature of experiments .. .. .. .. | 62 | 62 | 63 | 64 |
| Peripheral speed in feet per minute .. .. .. .. | 11 | 11 | 11 | 11 |
| Quantity of oil used for test (cc.) .. .. .. .. .. | 5 | 5 | 5 | 5 |
| Arc. .. .. .. .. .. | 40 | 25 | 40 | 35 |
| Coefficient of friction .. .. | 0·0084 | 0·0052 | 0·0084 | 0·0073 |

A. Pure mineral oil.
B. 97 per cent pure mineral, 1 per cent pale cylinder (added to keep the viscosity constant), 2 per cent commercial fatty acids.
C. 80 per cent mineral, 20 per cent olive.
D. 40 per cent mineral, 60 per cent olive.

In our case we add only very minute amounts of fatty acids, and the quantity is strictly limited and controllable. But where fatty glycerides are employed, the amount of acidity which can form is potentially very large because hydrolysis is constantly going on, giving rise to the production of free acids.

During recent years a great deal of attention has been devoted to the study of the colloidal characters of the fatty acids, and it has been shown that while the lower members of the fatty acid group possess relatively little colloidal character, the higher members are highly colloidal in character. Donnan and Potts have shown that there is a gradation in these properties as one ascends the scale, lauric acid occupying a sort of intermediate position. Also the lower members of the series possess strong acid characteristics, while the higher members are very weakly acid. Now the fatty acids which occur in commercial oils are never pure chemical individuals, but are mixtures in varying proportions of a considerable number of fatty acids. Coconut oil, for example, is characterised by containing appreciable percentages of the lower members of the series, while rape oil rarely contains anything but the higher members.

It is only to be expected, therefore, that the behaviour of these oils will differ in accordance with the fatty acid groups which predominate in them, and it is possible to reproduce the capillary properties of any particular anima

* From the *Journal of the Society of Chemical Industry*, March 1 1920.

or vegetable oil by adding suitably chosen fatty acids to mineral oil.

Consider the case of a steam engine using saturated steam, where there is a tendency for condensation of water to occur in the cylinder and valves. It follows in such a case that the presence of a substance in the oil which lowers the surface tension against water will in such circumstances assist in the formation of oil films by enabling the oil to spread more readily or by overcoming the tendency of the water to wash the oil film off.

There is a certain type of lubricating phenomena to be considered where the oil is brought into contact with water, and it is desirable that the oil shall either separate itself rapidly from the water (de-emulsification) or, conversely, that it shall mix or emulsify with the water.

Now the phenomenon of emulsification is dependent upon the colloidal properties of the oil, while de-mulsification is brought about by a greater concentration of hydrogen ions. Consequently one would expect the oil containing the higher members of the fatty acid group to possess an emulsifying tendency, while one containing the lower members will possess a de-emulsifying tendency. This is a feature which we have tested by shaking oils and water at various temperatures for long periods of time, and to a great extent we have been able to substantiate this view as the result of experiments.

After the soundness of our theory was clearly demonstrated in the laboratory, it remained for us to put it to the touch of actual practice to prove its real value in the world of engineering.

Not a single failure has occurred in practice of an oil or an oil "essence" made on the "germ process" as a reliable lubricating oil when used for the purpose for which it was supplied. The meaning of "oil essence" is explained later.

We use the expression "germ process" to describe the oil made by using one or more fatty or other acids with one or more mineral oils, because the world has been taught for generations to look upon acid as the deadliest enemy to good and safe lubrication. As the *germ* is the first principle of organic life, by analogy we call a suitable acid when dissolved in mineral oil the "germ," which gives to mineral oil its life and activity as a more perfect "instrument of lubrication."

We do not claim that a "germ process" oil is better for all conditions of lubrication, but for many purposes where lubrication depends upon the oil alone and not upon any mechanical means, such as pressure, to maintain a continuous film.

We have proved to our entire satisfaction that the addition of fatty oils to mineral oils for many purposes of lubrication is unnecessary and a waste of valuable material, and that for such purposes oils combining small percentages of suitable free fatty acid or acids with suitable mineral oils are at least equal to oils compounded on the old formulæ for those purposes. Therefore many of the old formulæ and specifications for compound oils are obsolete. Where the expression "compounded oils" is used, it indicates such old formulæ oils. Also, "mineral oil" indicates in many cases one or more than one mineral lubricating oil. "Fatty oil" includes tallow or other fats" used for lubrication.

*Gas Engines.*—It has always been considered that the addition of coconut oil to a mineral oil gave the best results. Refined rape oil or other fatty oil was also used in conjunction with coconut oil to the extent of about per cent of each; that is, about 10 per cent of fatty oil, per cent mineral oil. Especially on large horizontal units such a compounded oil was deemed essential. For smaller units smaller proportions down to 5 per cent total fatty oil to 95 per cent mineral oil; though some small units apparently required heavily compounded oils.

So far as our business is concerned, "germ process" oils have entirely displaced such compounded oils for horizontal and vertical engines up to the largest units of both types.

Some gas engines run on "straight" mineral oil with good results, but roughly it can be claimed that ten run on "germ process" oil to one on straight mineral.

*Oil Engines.*—Compounded oils, and for some "straight" fatty oils such as olive oil, have been considered essential for oil engines. For several types it was thought necessary to use a compound of *one-third refined rape oil* to two-thirds mineral oil. That oil has been entirely superseded by an oil with a slightly higher percentage of fatty acid than the average "germ process" oil for oil engines, but not over the maximum considered safe in practice. For other oil engines, land and marine, for which compounded oils were thought necessary, their place has been taken by oils made from one or more acids with mineral oils of suitable quality.

The quality of the mineral oil with which the acid is blended is a very important factor in lubrication. The germ process gives to a mineral oil of fair merit a property lacking for some purposes; while it increases the lubricating value of a "good" oil, making it better for many purposes. In both cases they become more economical.

*Steam cylinder lubrication.*—It is almost universally considered that for "perfect" lubrication of steam cylinders with certain types of valve gear (as one example "Corliss"),—and for engines working under certain conditions—say with much condensation in the cylinder—compounded oil is essential.

"Germ process" oil incorporated in very small proportion with the correct mineral cylinder oil gives equally good results on engines with Corliss valves up to 3000 b.-p. working at 160—170 lb. per square inch pressure, superheated 480-500° F.; on horizontal engines with Corliss valves up to 750 b.-p. up to 160 lb. pressure without superheat. Various mineral cylinder oil bases with correct "germs" in different but small proportions give thoroughly good lubrication on vertical and horizontal engines of many types, sizes, and pressures.

*Oils for steam turbines, crank cases of vertical steam, gas, and oil engines.*—The property most essential in oils for steam turbines, namely non-emulsification, is the one which largely governs successful crank-case lubrication of vertical engines. In such cases and in turbines water from condensed steam or from the cooling system finds its way into the crank case and gets "churned" as it is pumped round with the lubricating oil. For these conditions one has to know something about impurities in the water, as the water is the deciding factor. The "germ" must be carefully adapted to the water as well as to the oil, and the oil to the mechanism. Where one oil is used for cylinder and crank-case lubrication (say, of gas and oil engines) the "germs" can be balanced to give what for convenience can be described in a general way as a positive effect in the cylinder where extra capillarity is required, and a negative effect in the crank case where emulsifying is undesirable, and where the engine is steam of the splash lubrication type, to give just enough emulsion and no more for its intended work in the cylinder, also in the crank case, where it must emulsify. The germs, for they are many, can be so adapted, when one thoroughly apprehends their properties, to give perfect lubrication in all such cases.

*Marine steam engine bearings—open type.*—For a good heavy marine engine oil it has always been considered necessary, and is so to-day, to use from 10 to 25 per cent thickened or brown oil—as a rule, thickened rape oil. This gives great viscosity, also very good "lathering" properties to the oil.

The standard specification for marine bearing oil of one of our semi-Government departments is a compound of about 20 per cent "of fatty oil"; but the total fatty acid content must not exceed 1 per cent. This has now been successfully replaced by "germ-process" marine engine oil.

On February 5th, 1918, we filed our patent (Eng. Pat. 130,677; see *J. Soc. Chem. Ind.*, 1919, 674A) for oils ma

...is process, and immediately its "publication or communication" was prohibited by the Admiralty, who ...ed out trials over many months on about fifteen ships ...e mercantile marine, including a fair proportion of ... The result was quite satisfactory.

...this stage we decided to supply the fatty acids in a ..., which we term "essence," mixed with mineral oil which can be conveniently used on board ship; about ...er cent is added to the mineral oil as required. The ...t justified all claims. The consumption of mineral ...was considerably reduced, hot bearings were cooled, thrust blocks were kept cool by the addition to ...ral oil of suitable "germs." The trials were a com... success.

...e think it desirable to say that it may not be advisable ...il users in general to buy fatty acids, to mix them in oil and imagine all advantages mentioned will accrue. ...able acids must be chosen for the purpose.

*...nclusions.*—We have shown (1) that fatty compounded ...are unnecessary for many purposes of lubrication; ...hat fatty oils are not essential for such work; (3) that ... acids can entirely and completely displace fatty oils ...those purposes.

...ur thanks are here recorded to the following for invaluable assistance in our experiments and trials:—Prof. W. McC. Lewis; Messrs. Armstrong, Whitworth, and ... Ltd.; Corporation of Manchester Electricity Dept.; ...M. Shenton.

DISCUSSION.

...r. L. ARCHBUTT said that he had made some friction ...s with the process in the laboratory. It was obvious ...under the conditions which obtained in an ordinary ...nal bearing running at a good speed, in which a film ...iquid oil completely separated the journal from the ...ing, fatty acids could be of no advantage, and that the ... way in which they could act beneficially would be by ...roving the oiliness of the lubricant. The Thurston ...hine, as generally used, would not have measured ...thing but the fluid or viscous friction, but by running ...machine at a very low speed and with a good load on ...bearings a certain amount of contact friction had been ...ained, and in all the tests he was about to describe the ...ed was 7 ft. per minute and the load about 270 lb. per ...are inch. A few preliminary tests were made with ..."onicol," containing about 25 per cent of free fatty ...ls, and these showed that 2½ per cent of "Tonicol" ...ed with mineral oil lowered the coefficient of friction ...he same extent as about 10 per cent of ordinary com...rcial rape oil. Further tests had been made with a ...affin base oil of practically the same viscosity as rape ... at 60°–65° F., the temperature in all the tests. In each ...es the machine had been run with the mineral oil ...ne until the friction had become steady; then, without ...pping the machine the oil had been changed to a mix...e containing fatty acids prepared by himself from rape and then a final check test was made with mineral oil ...ne. The results of the first series are given in Table V.

TABLE V.

| | Mineral oil. | Rape oil fatty acids. | Friction coefficient. |
|---|---|---|---|
| 1. | 100·0 | nil. | 0·0066 |
| 2. | 99·5 | 0·5 | 0·0049 |
| 3. | 99·0 | 1·0 | 0·0045 |
| 4. | 98·0 | 2·0 | 0·0042 |
| 5. | 100·0 | nil. | 0·0066 |

...is was conclusive. In further tests nearly 80 per cent perfectly neutral rape oil, specially prepared, had been ...uired to reduce the friction as low as 2 per cent of rape fatty acids; 100 per cent of the rape oil had actually ...en a rather higher average friction, but this small ...ference was within the limits of the error of the method. ...e results are given in Table VI.

Finally, another series of four tests had been made, comparing the mineral oil, commercial rape oil, and neutral rape oil, and the results are given in Table VII.

TABLE VI.

| | Mineral oil. | Neutral rape oil. | Friction coefficient. |
|---|---|---|---|
| 1. | 100 | nil. | 0·0066 |
| 2. | 90 | 10 | 0·0065 |
| 3. | 80 | 20 | 0·0062 |
| 4. | 60 | 40 | 0·0053 |
| 5. | 40 | 60 | 0·0047 |
| 6. | 20 | 80 | 0·0041 |
| 7. | nil | 100 | 0·0043 |
| 8. | 100 | nil | 0·0062 |

TABLE VII.

| | Oil. | Friction coefficient. |
|---|---|---|
| 1. | Mineral oil | 0·0078 |
| 2. | Neutral rape oil | 0·0050 |
| 3. | Acid rape oil (2·4 p.c. fatty acids) | 0·0045 |
| 4. | Mineral oil | 0·0078 |

These results appeared to him to prove the authors' contention as regards the friction-reducing value of free fatty acid to be perfectly sound, but he could not agree that the lowering of the interfacial tension between oil and water, or even oil and mercury, though very interesting and important, was a sufficient explanation of the nature of oiliness. The authors' own experiments showed that the interfacial tension between nearly neutral rape oil and water was almost as high as that of mineral oil, and much higher than that of acid rape oil. Yet his (Mr. Archbutt's) experiments showed that neutral rape oil when mixed with mineral oil lowered the friction, and there was very little difference between the coefficients given by neutral rape oil and acid rape oil. Mr. Deeley, in his recent communication to the Physical Society, had expressed the opinion that oiliness was a chemical property, and that the unsaturated molecules of the lubricant united with the solid metal surface and formed a new surface which opposed less resistance to shear than the unlubricated metallic surface. The remarkable papers by Langmuir and Harkins strongly supported this view. Langmuir said: "Since energy must be expended in breaking apart a solid, the surfaces of solids must contain more potential energy than do the corresponding number of atoms in the interior. Since the potential energy is probably electromagnetic energy in the field between the atoms, the interatomic forces are more intense on the surface than in the interior. This intense field (unsaturated chemical affinity) is one of the causes of the phenomena of condensation and absorption" (*J. Amer. Chem Soc.*, 1916, xxxviii., 2293), and in a later paper, after describing a number of experiments, Langmuir said: "These results afford the strongest kind of confirmation of the theory that the spreading of films on surfaces is determined by the shapes of molecules and the relative activities of the different portions of the molecules" (*ibid.*, 1917, xxxix., 1881). "Consider first the adsorption of a liquid containing active groups. The molecules will become orientated and will pack into the surface layer in much the same manner as in the case of oil films spread on the surface of water" (*ibid.*, xxxix., 1901). W. B. and F. K. Hardy (*Phil. Mag.*, 1919, xxxviii., 33) had come to a similar conclusion. They said that "the function of a lubricant is to reduce the energy of the surface, and thereby to reduce the capacity for cohesion and the resistance to slip when two composite surfaces are applied the one to the other." All recent work pointed to the fact that it was the chemically reactive and unsaturated constituents of lubricants which promoted oiliness, and that they do so by forming new composite films on the surfaces lubricated, with lower surface energy and opposing less resistance to shear, an...

the great activity of free fatty acids was quite in accordance with this theory. Referring to the statement in the paper as to the occurrence of hydrolysis and formation of free acids in oils, he did not think much hydrolysis took place in an ordinary bearing, but it did in a steam cylinder. He agreed that so long as the quantity of free fatty acid in a lubricating oil did not exceed 1 or 2 per cent, which was as much as was necessary, as his own tests had shown; ½ per cent did most of the work, and an addition up to 2 per cent did not make a very great difference; this small quantity of fatty acid could not do any possible harm and was far more useful than a larger quantity of fatty oil, besides the saving it effected. A little misconception might arise from the statement attributed to him that 1 per cent of free fatty acid lowered the coefficient as much as did 60 per cent of pure rape oil. That was not commercially pure rape, but a special neutral rape oil which he had made in the laboratory, and which was not an article of commerce. He was struck by the fact that 80 per cent of mineral oil and 20 per cent of olive oil made no difference to the friction coefficient, and that 60 per cent mineral oil and 40 per cent olive only lowered it to 0·0073. He wondered what that olive oil was. The sentences quoted in the paper from the communication which he himself had made to the Physical Society needed the context, because what he meant was that, comparing acid rape oil with neutral rape oil, there was not very much difference, so that the effect of the free fatty acid in the rape oil was not nearly so great as when it was added to the mineral oil.

Mr. Arnold Philip agreed with Mr. Archbutt that the authors had not succeeded in showing what oiliness was. Oiliness could not be explained as being merely due to the wetting of the rubbing surfaces by the lubricant, because glycerin, which had a very similar viscosity and density to that of some oils, would certainly wet ordinary bearing surfaces, but as a lubricant it was, of course, valueless. The property of "oiliness" possessed by lubricants, including the views to which Mr. Archbutt had referred, had up to the present only been measurable by the results obtained when using the lubricant on machinery under ordinary running conditions or by special tests made with mechanical oil testers, such as that of Thurston. The authors' results, however interesting, were not referred to these standards, and as an explanation of oiliness were, he considered, meaningless. General commercial practice had shown for many years past that the admixture of small amounts of fatty oils with mineral oils did distinctly improve the mineral oil for many purposes. He believed that this had been stated to be due to the formation of metal soaps on the bearing surfaces. In any case he had this explanation very strongly indicated in his own practice by the fact that some fourteen years ago difficulty had been experienced with machinery running at low temperatures, due to solidification of the sperm oil which was used as a lubricant. To remedy this a pure non-freezing mineral oil had been substituted for the sperm oil. The result had been that the mineral oil had come away from the bearings full of turbidity, caused by flakes of solid material, which consisted of oleates and stearates of iron and copper stripped from the bearing surfaces. These had been formed by the use of the sperm oil in the first place, and this solid coating of the metal bearing surfaces was afterwards become displaced and washed out by the mineral oil subsequently used. As this mineral oil was a perfectly clear, water-white liquid, the presence of the flakes of oleates and stearates in it after use had been very evident. After the stripping of these heavy metal soaps from the bearing surfaces by the mineral oil it had been found that the friction had increased, but whether this was actually due to the removal of the stearates and oleates was not quite clear. Some eight or ten years ago he had had the important function of the free fatty acid in such lubricants still further impressed upon him by the manufacturer of a fatty oil, for making blended or compounded fatty and mineral oils for lubricants, who had informed him that he always made an oil containing a large percentage of fatty acids. In fact, he spoke of the use of this acid fatty oil as being a special secret, and stated that it gave particularly satisfactory results for making blended lubricating oils. Consequently, when about two years ago the proposal of the authors for using mixtures of fatty acids and mineral oils had been referred to him by the Admiralty, he had approved it and reported that it appeared, on the face of it, to be good not only on account of the saving in fatty oils which it effected, but also because the use of compound mineral oils and fatty acids appeared technically correct for certain lubricating purposes. What the authors had done which was novel was to use a fatty acid as distinct from a fatty oil for blending with mineral oils. He deprecated the use of the term "germ" as applied to the process and also the use of the word "essence," both of which were misleading.

In a written communication Prof. F. G. Donnan pointed out that a great deal of the matter brought forward apparently as novel by the authors had been already discussed and elucidated by himself. For example, he had shown experimentally so long ago as 1899 (*Zeit. Phys. Chem.*) that the interfacial tension between a fatty hydrocarbon oil and an aqueous solution was dependent mainly on (*a*) the presence of alkali in the water, (*b*) the presence of free fatty acid in the oil. In the paper referred to the quantitative dependence of the interfacial tension on these two main variables had been experimentally measured, and the cause of these phenomena fully elucidated. Many other important interfacial tension and concentration effects had been investigated in later papers by his pupils (work of Lewis, Potts, Barker, Ellis, Powis) working under his direction.

Mr. T. Thornley asked if the authors had used aqueous emulsions as lubricating agents. The function of a lubricant was to keep metal surfaces separate with as little expenditure of energy as possible, and if an aqueous emulsion were used an effect was obtained similar to that of a ball bearing. It gave the superiority of a ball bearing over an ordinary friction bearing. Instead of having a reduction of about 60 per cent by introducing fatty acid an aqueous emulsion containing about 25 per cent mineral oil would reduce the expenditure of energy by at least 85 per cent; *e.g.*, when using 100 ampères at a known voltage with a full mineral oil and then turning over to an aqueous emulsion containing 25 per cent of some mineral oil the current expenditure had fallen to 15 ampères. Such an emulsion could be prepared by homogenising a mineral oil and soap solution containing 2½ per cent of ordinary soft soap. These emulsions had been used in certain special cases with a good deal of success for something like twelve months on fairly heavily loaded bearings at medium speeds.

Dr. W. R. Ormandy said that it seemed impossible to draw the conclusion that interfacial tension was the basis of what was called "oiliness," because certain experiments with an oil containing free fatty acids as against water gave a certain result which was more or less directly comparable with the results obtained in practice on a metallic surface, and it would have been wise to have tried the experiment of oils in other liquids, with which they were immiscible, in order to see in the first place if the interfacial tension between the other liquids bore anything like the same ratio to the results on a metallic surface. He thought that Mr. Archbutt had adequately explained the bearing of Langmuir's theory of surface energy in its relation to the question of lubrication. Langmuir would contend that on the surface of the metal there were certain free fields, and these free fields or residual valencies could attract a certain number of fatty oil molecules until they were saturated. Langmuir had proved by many experiments that once they had satisfied all the free valencies, as it were, on the surface and had got it covered with a layer one molecule thick, the attraction afterwards did not count, and any addition to the oil produced a very small effect. Similar results had been obtained by Hardy, who had shown that

r one molecule thick was sufficient to prevent adhe- of one glass surface to another. Therefore if there sufficient of the fatty acid, or whatever material it adsorbed on the metal surface to satisfy the valencies it surface, any further addition would produce a com- ively slight effect. That was borne out by Mr. Arch- s first series of experiments.

of. J. S. S. BRAME, in referring to the work which already been done on this subject, particularly by butt and Deeley, and described in their papers before Physical Society, said that Messrs. Hardy had carried xperiments on the static friction with different fatty , ranging from those of low molecular weight to high cular weight, and it was shown, not only in the case ese fatty acids, but in the case of alcohols and amines, increase of molecular weight was associated with a ressive decrease in static friction. That seemed to a very important bearing on the question under dis- ion, and he asked whether the authors found that was any relationship between the molecular weight atty acids and the friction of the hydrocarbon oil ore. Did the authors find that a saturated fatty acid pproximately the same molecular weight as an un- rated fatty acid had the same effect? In one of the s the interfacial tension with water between olive oil coconut oil containing approximately the same amount tty acid was practically the same, viz., 72 to 68. The iodine absorption number for the fatty acid from oil was about 90, and for the fatty acid from coco- oil it was 9, which suggested that perhaps there was much difference between the action of a saturated and nsaturated fatty acid. Was there any connection een the action of a given fatty acid with different s of hydrocarbon oils where there was consider- variation in the amount of the unsaturated ocarbon present—for example, the average shale cating oil, which was rich in unsaturated hydro- on molecules, and a "straight" petroleum lubricating where the proportion of unsaturated molecules was much less? He agreed with Mr. Archbutt and Arnold Philip, however, in thinking that the authors ied the matter very much further towards arriving at a tion of what "oiliness" really meant.

r. A. A. DRUMMOND said that some years ago a letter appeared in the *Engineer* dealing with the corrosion eel balls through the action of lubricating oils, includ- mineral oil and fatty oils, like olive oil and lard oil. o case, after six months, had there been any sign of osion except with castor oil, and this had shown e appreciable corrosion visually, particularly under microscope. Not only had castor oil shown this differentiated itself from the others, but the e difference had been noticed in the case of fatty acid of castor oil as compared with the corre- ding acids of the other fatty oils. Perhaps the ior could offer some explanation of the difference bited.

r. SOUTHCOMBE, in reply, said that they were not ous to make out a theory. They had observed certain rences in interfacial tension of commercial lubricating against water, and then stated the further fact that presence of fatty acidity lowered the frictional co- ient, and they supported that by a further fact that presence of this fatty acidity also lowered the tension nst mercury surfaces. Even if residual valency were explanation it would manifest itself in the same way; it would cause a lack of abruptness of the transitional r, and that diminution in the abruptness of the transi- al layer would manifest itself as a lowering of the facial tension, and therefore it was only a question of ch side one looked at the problem from. With regard residual valency, unsaturation was the essence of gmuir's theory, unsaturation in the sense of the pre- e of matter of which the valencies were fully saturated r as ordinary chemical reactivity went, but which had ably some unsaturated linkages not satisfied. The hydrocarbons which constituted mineral lubricating oil were more highly unsaturated than were any of the com- pounds of the fatty glycerides, taking saturation in the chemical sense. From the experiments of Mabery and others it was seen that the mineral oils which had high viscosity and were very much used as lubricants were characterised by very high unsaturation. In the two oils dealt with in the paper, and from Mr. Archbutt's experi- ments, he suggested that the one which Mr. Archbutt called mineral oil, 100, was more highly unsaturated than was the pure rape oil, so that if the view point of the authors had not been proved, he did not think they were very much advanced from a practical point of view by the Langmuir idea. Mr. Arnold Philip had suggested that the effect of the fatty acid was to form metallic soaps. If this were the case in any short period of time then it must be a definite proof of the adsorption idea. The case which Mr. Philip had brought forward was not parallel. He had spoken of a bearing running on sperm oil and changing that for a mineral oil. The sperm oil might have been in the bearing for a very long period, and would necessarily have corroded the bearing to a certain extent. On the other hand, the fact that the coefficient of friction was lowered instantaneously by the addition of fatty acids, as shown by the authors' figures and confirmed by Mr. Archbutt, was proof that that had nothing to do with wholesale soap formation. There must be adsorption which would secure an almost instantaneous lowering. He could not agree that the example given of glycerin dis- proved the "wetting" view. Glycerin was quite a good lubricant, but its hygroscopic properties made it com- mercially useless, because in practice it rapidly becomes an aqueous solution. It was true that Prof. Donnan had shown how to determine the adsorption on sur- faces of fatty acids in oils in alkali solution, but the object of his paper was to take a series of fatty acids, from acetic to stearic, and determine the interfacial tension against alkali solution by the drop pipette, and he (Prof. Donnan) had succeeded in showing that as the series was ascended the surface tension became very much lower, but he was not concerned with a diminu- tion in interfacial tension against water. Prof. Donnan's results were of a totally different order of magnitude. His drop number went up from, say, 100 to 200, 300, and 400, against dilute alkaline solutions, which was what he was measuring. Donnan's work did not refer to the problems of lubrication. It was true that the drop pipette method had been applied by Prof. Donnan and his collaborators, but what the authors were claiming to show was that such an instrument could be used in the examination of an oil. They were glad to take this opportunity of stating that Prof. Donnan's work on the drop pipette had been inspiring and of value. Mr. Thornley had spoken of aqueous emul- sions of lubricating agents. He (the author) did not know the conditions under which these emulsions had been employed, although their use was not new. The only point there which would interest him was the question of the "wetting." Such emulsions were generally pumped under forced feed, and it did not concern the present paper. In reply to Prof. Brame, they had not done anything to show the variation of the frictional coefficient with the molecular weight of the acid. They had, however, carried out a series of experiments with regard to emulsification and de-emulsification which would be published shortly. He did not think that a research as to the effect of degrees of saturation would be very fertile, because, as he had already pointed out, there was equal unsaturation in a great number of the mineral oils themselves possessing high frictional coefficients as compared with the unsatura- tion of the fatty glyceride. In reply to the other point raised by Prof. Brame, there was a very distinct influence on the properties of the final lubricants by adding different fatty acids to any given mineral oil, and there was also a different result with a compounded oil obtained with one given series of fatty acids with different hydrocarbon oils,

With regard to Mr. Drummond's query on the question of corrosion of steel balls and the effect of castor oil, he did not think that came within the scope of the paper. The only thing he could suggest was that with castor oil acids were formed by oxidation which would be very dangerous from the corrosion point of view. These, however, were not the acids used in compounding lubricating oils.

(To be continued).

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, May 20, 1920.*

Sir J. J. THOMSON, O.M., President, in the Chair.

THE following papers were read :—

"*Some Notes on Krypton and Xenon.*" By Prof. J. N. COLLIE, F.R.S.

In this paper the measurements of a considerable number of new spectroscopic lines at the red end of the spectrum are given; also a curious property of xenon has been noted. In tubes containing xenon, when a strong current from an induction coil is passed, much splashing of the electrodes occurs, and the xenon disappears as a gas. What becomes of the xenon is not clear, as it does not seem to be liberated again, either by strongly heating the metallic splash, or by dissolving up the splash in suitable solvents.

"*Experiments on Electron Emission from Hot Bodies.*" By SIH LING TING.

Experiments on the electron currents from a platinum disc in a uniform field made by Prof. Richardson in 1907—1909 showed that under the conditions of these experiments the distribution of velocity among the emitted electrons was very close to the requirements of Maxwell's law for a gas of equal molecular weight and temperature; but it was noted at the time that rough tests made on the liquid alloy of sodium and potassium, on platinum coated with lime, and on platinum saturated with hydrogen indicated an exceptional behaviour. The further investigation of these substances was postponed owing to technical difficulties and to the pressure of other problems. In 1914 Schottky investigated the electrons emitted from tungsten and carbon, and found a distribution of energy in close accordance with Maxwell's law, except that the mean energy varied between 2 per cent and 25 per cent in excess of that calculated from the filament temperatures. Errors in the estimation of these temperatures and in other directions might, however, have accounted for these discrepancies.

The present experiments show that deviations from Maxwell's law, if not general, are at any rate quite common. With tungsten and platinum in a well-exhausted enclosure, a common distribution is one which satisfies the requirements of Maxwell's law, except that the average electron energy is in excess of (frequently about twice as great as) that corresponding to the temperature of the source. Other cases have been recorded in which the velocity distribution has a functional form different from that of Maxwell's law. With lime-coated platinum the emission energy is either exceptionally low or else the method of investigation gives illusory results.

Data are also given showing interesting hysteretic effects in the electron currents. It may be that such effects indicate the presence of some residual gas in the tubes, and that the deviations from Maxwell's law are in some way connected with such contamination. However, every precaution was taken in the preparation of the tubes to ensure freedom from gas, and they were undoubtedly far superior in this way to the tubes used in the old experiments which gave results in agreement with Maxwell's law.

"*The Aspherical Nucleus Theory applied to the Balmer Series of Hydrogen.*" By L. SILBERSTEIN.

The general formulæ for spectrum emission by atomic systems containing an aspherical nucleus, given by the author in a previous paper (*Phil. Mag.*, xxxix., 76) applied to hydrogen atoms, whose nuclei are treated as axially symmetrical charged distributions. The aspheri[city] and the value of the Rydberg factor are determined [from] Mr. Curtis's observations of $H\alpha$ up to $H\gamma$. The s[eries] formula thus resulting (and containing but two const[ants]) is shown to agree well with the six observations. [The] value of the asphericity coefficient is then used to deter[mine] the fine structure of the members or groups of the Ba[lmer] series, more especially of the groups $H\alpha$ and $H\beta$, which [are] discussed in some detail.

"*Conditions at the Boundary of a Fluid in Turb[ulent] Motion.*" By T. E. STANTON, F.R.S., Miss D. MARSH and Mrs. C. N. BRYANT.

Observations were made on air flowing through pipes of circular cross section at mean rates of [flow] covering as wide a range as possible, below and above critical speed. Dimensions of pipes used were 0[...] 0·714, and 12·7 cm. in diameter. Range in experim[ental] conditions varied from—

$$\frac{vd}{\nu} = 460 \text{ to } \frac{vd}{\nu} = 325{,}000$$

where $v$ is mean speed of flow, $d$ diameter of pipe, a[nd $\nu$] kinematic viscosity of air. Estimation of velocity of [air] in neighbourhood of boundary was made from observat[ion] of difference in pressure existing in a small Pitot [tube] facing direction of flow, and that in a hole in the wa[ll of] the pipe.

The Pitot was of rectangular section, external dim[en]sions at orifice being 0·1×0·8 mm. and internal dimens[ions] 0·05×0·75 mm.

By this means observations could be made up [to a] distance of 0·05 mm. from the wall. For distances [less] than this, by a special device, the wall of the Pitot nea[r] the wall of the pipe was cut away and its place taken [by] the wall of the pipe. By this means observations c[ould] be taken at a distance of 0·01 mm. from the walls.

From a comparison of the curves of velocity distr[ibu]tion near the boundary, obtained from observations [with] the Pitot and the composite tube, it was found that in case of the former the interference with the flow near orifice by side of tube adjacent to boundary was considera[ble]. Velocity curves obtained from the composite tube, w[hen] further corrected for interference, were found to tend [to a] definite slope at boundary, which was identical with t[hat] which would exist in a layer of fluid in laminar mot[ion] and having same surface friction as that actually measu[red].

### PHYSICAL SOCIETY.

*Ordinary Meeting, May 14, 1920.*

Prof. Sir W. H. BRAGG, F.R.S., President, in the Ch[air].

A Demonstration of Experiments on the Thermio[nic] Properties of Hot Filaments was given by Dr. F. LLC HOPWOOD.

The experiments shown were some of those describ[ed] by Dr. Hopwood in the *Philosophical Magazine*, Mar[ch] 1915, p. 362 in which the glowing filament of a carb[on] lamp, and glowing filaments of nichrome and platinum [in] air, are made to move under the influence of positively a[nd] negatively charged rods brought into or withdrawn fr[om] their vicinity; the character of the effects obser[ved]

ing such as to give a qualitative indication of the ermionic emission from the filaments. In addition he iowed a type of tilted electroscope in which the gold af was replaced by a narrow loop of Wollaston wire. /hen a current is passed through the wire so as to make glow it forms an electroscope of different sensitivity for -ve and −ve charges.

DISCUSSION.

Mr. W. R. COOPER asked if the experiments had been ied with lamps lacquered with coloured lacquers. He ad seen one covered with a red lacquer, the filament of hich would move about following movements of the nger outside.

Dr. D. OWEN asked what was the explanation of the symmetry of the electroscope. Did it depend on the irection of the current in the filament, or did it work as vell with alternating current?

Dr. HOPWOOD said it was possible with lacquered amps that one got an adventitious charge on the globe which reacted on the filament. He mentioned that during he war he knew of a number of lamps which in order to bscure them were dipped in "tantalum paint." This was o easily electrified when touched by dry hands that about o per cent of the filaments broke.

In reply to Dr. Owen, the electroscope worked equally vell with alternating current.

A paper on "*A Modified Theory of the Crookes Radiometer*" was read by Mr. G. D. WEST.

The paper gives a short account of a theory of the Crookes Radiometer worked out by Sutherland in 1896, but unfortunately much neglected. The theory as it stands will not explain many radiometric phenomena, but it is shown that when modifications, depending on the modern knowledge of thermal surface conditions, are made, such explanations become possible.

Radiometer action, especially at the higher gas pressures, would appear to depend essentially on the formation of gas currents near the radiometer vane. These currents are distinct from convection currents, but are closely associated with the phenomena of thermal transpiration.

DISCUSSION.

Mr. F. J. W. WHIPPLE pointed out that as the isothermals were drawn in Fig. 1 they indicated that the colder side of the vane was actually colder than the walls of the bulb, whereas actually it was hotter. He indicated alterations in the shape of the isothermals which would correct this. In connection with the general presentation of the problem he would have liked it better if it had been based more on kinetic theory and less on hydrodynamical flow. It was necessary to introduce kinetic theory to explain the difference of pressure between the hot and cold ends of a tube. When the mean free path was large, a particle entering one end of the tube would strike the sides tangentially and pass through the tube. When equilibrium was reached the number of particles entering at each end must be equal, so that $pv = p'v'$. But the condition for equality of pressure was $pv^2 = p'v'^2$.

Mr. WEST, in reply, said he was not quite clear at the moment on the point raised about Fig. 4. He would look into it and communicate a reply. In an earlier paper he had pointed out what Mr. Whipple had just mentioned, that at low pressures it was the conservation of matter that determined equilibrium, while at high pressures it was the equality of pressures.

A paper "*On the Magnetic Properties of Silicon Iron (Stalloy) in Alternating Magnetic Fields of Low Value,*" by Mr. ALBERT CAMPBELL, was read by Mr. D. W. DYE.

Measurements are described of the hysteresis-losses in silicon iron sheet and wires in very low alternating magnetic fields at low and telephonic frequencies using an alternating current method described in a former paper. The equations giving the hysteresis losses as a function of $B_{max}$, are deduced in the case of the sheet material at low requencies for ranges of $H_{max}$, from 0·0002 to 0·02.

Comparisons are made between sheet material and wires of different diameters, and curves are given showing the great improvement in the permeability of wires when they are annealed.

The behaviour of the material is studied, both by ballisti tests and at telephonic frequencies, as regards th alternating field when direct current fields of variou values are applied at the same time.

DISCUSSION.

Mr. POLLOCK said he was much interested in the metho of measurement, and would try it at the first opportunit He had usually employed modified Bridge methods, an had got down to magnetising fields of 0·02, but not so f down as the author. He was interested in the formula f eddy current losses. He had frequently found in measur ments with fine wire cores that the eddy current loss tak jumps due to the E.M.F.s set up being sufficient to mal the currents pass from one strand to another, and l thought it was impossible to calculate the eddy curre losses by any formula. It was important in practice wh measuring the losses in stranded cores to take account the value of the magnetic field to which the core would l subject in use, for with some fields the eddy curren would pass from strand to strand, while with others th would not. He was interested in the conclusion th hysteresis loss was proportional to the square of the fl density. He had had the impression that the loss becar very small at very low fields. With regard to Fig. 2, showi the permeabilities for unannealed and annealed stalloy, was most important in telephone work that the cores of t loading coils should be of constant permeability over t range of field to which they were subject in use. U fortunately such cores were liable to damage by excessi magnetisation due to accidental currents flowing throu the coils, as their permeability did not return to its init value. Many of the old coils had lost about 15 per c of their inductance from such causes. This could only recovered by re-annealing, and unfortunately annea stalloy had not constant permeability. On this acco the Americans were beginning to use granular cores.

Mr. RITTER asked if the windings were absolutely d as he had found that a trace of moisture in the dielec caused quite appreciable losses. He emphasised the i portance of constant permeability in the iron used loading coils. When a cable was loaded the impeda depended on the square root of the ratio of the inducta to the capacity per unit length. If the impedance alte with the current, difficulties were introduced, especi since the use of amplifiers became general.

Mr. DYE said the greatest care was always taken winding the coils to prevent the possibility of moist being present. As regards the telephone coils, was iron in its virgin state to start with? If the cores w magnetised strongly to begin with and then demagneti the properties in that state being used as the basi design, it would always be possible to regain the ini condition without re-annealing.

A paper "*On Tracing Rays Through an Optical Syste* was read by Mr. T. SMITH.

Equations for tracing rays in an axial plane throug optical system have the normal refraction terms separ from those representing aberrations. By expressing latter as a fraction with the first order aberration as numerator and a correcting factor, which may take var forms, as the denominator, rays may be traced exa through the system using a short table of cosines in term sines in place of the extensive tables, giving sines in te of angles generally employed. A considerable savin time is effected in the calculations, and the estimat without calculation, of the aberrations of other ray facilitated.

## MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

(CHEMICAL SECTION).

*April* 30, 1920.

Mr. J. H. LESTER in the Chair.

DR. J. A. R. HENDERSON read a paper on "*Alchemy and Chemistry among the Chinese.*"

Chinese alchemy is of great antiquity, and is closely connected with the religion of Tao which is indigenous to China, and which dates back to the sixth century B.C., if not to the beginnings of the Chinese race. The alchemists in China had the same objects in view as those in Europe at a much later time, viz., immortality and the transmutation of base metals into gold; their writings are obscure, and they failed in their great quest as did the alchemists of the west. However, the studies of the Chinese alchemists led to discoveries of practical importance in metallurgy, mineralogy, and botany. China abounds in natural wealth, and the Chinese have not been slow to avail themselves of this and to use it to their own advantage. The Chinese show great skill in metallurgy, and in the manufacture of pigments, lacquers, porcelain, paper, &c. They very early discovered the explosive properties of gunpowder, and made use of it in their wars. The great mineral and vegetable wealth of China gives promise of a great chemical industry in the future. Methods at present in use are primitive, but modern methods and machinery are beginning to be employed, and one can confidently look forward to the time when the latest methods will be used in the exploitation of the vast deposits of coal, iron, and other metallic ores, and in the production of oils, essential oils, and medicinal substances from vegetable sources.

*May* 14, 1920.

Prof. F. LEE PYMAN read a paper entitled "*The Relation between Chemical Constitution and Physiological Action.*"

## NOTICES OF BOOKS.

*An Introductory Course in Quantitative Chemical Analysis.* By GEORGE MCPHAIL SMITH. Pp. 206. 1919. New York: The Macmillan Co. Price 9s. net.

THE author of this work is to be congratulated on the thorough manner in which he has fulfilled his task. The book abounds with exceedingly practical hints, and the explanatory notes at the end of the determination of the various elements and compounds should prove very helpful to the student.

The text is divided into five parts, viz.: I. Introduction. II. Gravimetric Analysis. III. Volumetric Analysis. IV. Stoichiometry. V. Questions, together with an appendix containing logarithm tables, methods of preparing reagents, &c.

Criticism of Part I., which comprises some 52 pages, would be invidious, for the treatment given by the author to the everyday operations of the analyst can only be described as admirable.

The methods of gravimetric analysis in Part II. are described in a lucid manner, as also is the somewhat lengthier Part III. on volumetric analysis. In connection with the latter it is somewhat surprising to find that the author does not refer to the use of potassium chromate as an indicator in the titration of soluble chlorides with standard silver nitrate. The method given also for the determination of phosphorus in steel, whilst being of theoretical interest, will probably not find any extensive use.

Parts IV. and V., which consist mainly of quest[ions and] problems, conclude a course which would certa[inly give] the student a very sound foundation for his futu[re work] as an analytical chemist, and altogether the book [is] heartily recommended.

*Laboratory Manual of Elementary Colloid Ch[emistry].* By EMIL HATSCHEK. 1920. Pp. viii+135. [London:] J. and A. Churchill, 7, Great Marlborough [Street]. Price 6s. 6d.

A BADLY felt want is filled by the publication of th[is] book of 135 pages.

Lucid explanations are given to the various op[erations] which have to be carried out in studying the pract[ice] of colloidal chemistry.

The book is divided into 19 chapters, each dealing with a distinct operation or experim[ent; for] example, in Chapter II., entitled "Dialysis," methods for carrying out this operation are ex[plained,] these explanations being helped by the free employ[ment of] diagrams.

The book covers the elementary ground, giving [methods] for producing sols, gels, &c., followed by cha[pters on] cataphoresis, viscosity measurements, capillary a[nalysis,] the Liesegang phenomenon, &c.

For those who wish to penetrate further in[to the] experiment given, a good bibliography accompa[nies the] end of every chapter.

The author is to be congratulated in his me[thod of] describing the various experiments, which are writ[ten in a] way that any student should be capable of underst[anding].

*Manual of the Chemical Analysis of Rocks.* By [H.] S. WASHINGTON, Ph.D. Third Edition. Pp. x 1919. London: Chapman and Hall, 11, H[enrietta] Street, Covent Garden, W.C. 2. Price 11s. 6d.

THIS edition makes the third, the two previous bei[ng pub]lished in 1904 and 1910.

The book is divided into five parts, namely:—I. [Intro]duction. II. Apparatus and Reagents. III. The S[ample.] IV. Operations. V. Methods.

Part I. gives a brief sketch of chemical analysis. [Part] II. needs no further explanation. Part III. rela[tes the] methods to be employed in obtaining samples of roc[ks, with] special reference to the freshness of the sample. P[art IV.] gives some useful hints on the avoidance of er[rors in] ordinary chemical operations. Part V., which is th[e larger] half of the book, enumerates the methods emplo[yed in] the separation and estimation of the elements exis[ting in] the rock under examination.

A useful feature of this book is that in every [method] detailed the author enumerates the possible cau[ses of] errors and their avoidance.

In an appendix is given a useful list of factors f[or cal]culation, an example of an analysis of a rock, [and a] bibliography.

The book is written in a manner which should b[e] understood by all those whom it may concern, and [is re]markably free from errors.

SPRAYING METALS. — (*Electrician*, lxxxiii., 3[...]) Schoop's process of spraying metals is being f[urther] developed. Two wires of the metal are connected [to the] terminals of the electric circuit, then touched and sep[arated] to form an arc. This fuses part of the wires whi[ch are] fed forward continuously. An air blast projec[ts the] molten metal in finely-divided form upon any c[old] object. Glass, celluloid, paper, &c., are thus gi[ven a] metallic coating. Glass plates so prepared are us[ed as] electrical condensers. The process is employed a[lso to] secure good metallic contact and to facilitate sold[ering.] Electric heaters are made by spraying metal on refr[actory] substances.—*Journ. Franklin Institute.*

# HEMICAL NOTICES FROM FOREIGN SOURCES.

*mptes Rendus Hebdomadaires des Séances de l'Académie des Sciences.* Vol. clxx., No. 19, May 10, 1920.

SEPARATION OF TIN AND ANTIMONY. ESTIMATION OF IN BY CUPFERRON.—MM. A. Kling and A. Lassieur.—he authors, continuing the work of M. Auger (see HEMICAL NEWS, 1920 cxx., 262), have examined the use cupferron in the estimation of tin. After examining any methods for the separation of tin and antimony, one of which gave complete satisfaction, they concluded at F. W. Clarke's method (Treadwell, "Quantitative nalysis," p. 231) gave the best results. The method consists of the precipitation of antimony by hydrogen sulphide the presence of strong oxalic acid. Vortmann and etzel's modification (*Zeit. Anal. Chem.*, 1905, xliv., 525), which phosphoric acid replaces oxalic acid, according to e authors, gives fairly good results for antimony, but the sults for tin are bad. The authors have had quite good sults by the separation of tin and antimony by hydrogen lphide in the presence of hydrofluoric acid. They admit at this is not a new method, it being the subject of many emoirs. The principle of the operation is that if stannic lts are in the presence of hydrofluoric acid a complex lt is formed, the constitution of which is not well nown; but tin in this condition can be separated from her elements, antimony for example, either by hydrogen lphide or electrolysis. It is then easy to break up the n compound by the addition of boric acid. With modifications the authors have followed the method as laid own by Le Roy W. MacCay (*Journ. Am. Chem. Soc.*, 909 xxxi., 373–381), chiefly using cupferron for precipitating the tin, which on igniting gave $SnO_2$. The uthors then give a detailed account of the method they dopted, with their results, which are:—

| Theoretical. | | Found. | |
|---|---|---|---|
| Sn. | Sb. | Sn. | Sb. |
| 0·198 | 0·0428 | 0·197 | 0·042 |
| 0·305 | 0·0042 | 0·305 | 0·0038 |
| 0·326 | 0·118 | 0·327 | 0·117 |

# NOTES.

CHEMICAL SOCIETY.—By the courtesy of the Council f the Institution of Mechanical Engineers, the next rdinary Scientific Meeting of the Chemical Society on une 17th, at 8 p.m., will be held in the Lecture Hall of he Institution of Mechanical Engineers, Storey's Gate, .W.1, when Professor J. C. McLennan, F.R.S., of oronto University, will deliver his lecture on "Helium."

SCIENTIFIC RESEARCH IN RELATION TO THE GLASS NDUSTRY.—(Edward W. Washburn, American Ceramic ociety, 1919)—With the development of methods of producing, controlling, and measuring high temperatures in he laboratory our knowledge of the chemistry and physics f high temperature processes has steadily increased and pplications of that knowledge have naturally followed. The stimulus of the war has aided greatly in bringing ogether the practical man of the factory and the scientist f the laboratory. But in glass-making we know *how* to ay much better than we know *why*. Progress demands hat we know why. In industrial laboratories the work to e done may be roughly classified under three headings: 1) Routine testing of raw materials and products and imilar control work; (2) works problems, including the uring of troubles and the improvement of processes and roducts; (3) fundamental research to find out the *why* f the operations or to secure quantitative scientific data covering materials, processes, and products. In the glass industry almost all of the fundamental research work remains to be done. For example, very little is known of the relations between (1) viscosity, and (2) temperature and composition, although viscosity has long been recognised as of great importance in making and working glass. Surface tension and vapour pressure and even density have scarcely been studied at all. Of the reactions and compounds we know almost nothing. The nature of gases remaining in solution is almost unknown, as well as their effect, if any, on the properties of the glass. Many unanswered questions are referred to, including relations between composition and properties, cause of greenish colour resulting from substituting soda for potash, the condition of copper in glass, the cause of pink colour from manganese and red in chrome pink, the function o arsenic. There are three types of laboratories to carry ou such researches: (1) industrial, (2) government or researc foundations, and (3) university. The endowment c research professorships in glass would have a very stimu lating effect.—*Journ. Franklin Institute.*

THE PENETRATION OF IRON BY HYDROGEN.—T. S. Fuller American Electrochemical Society, 1919.)—The result are given of experiments showing the effect of variou conditions on the penetration of iron by nascent hydroge at temperatures from 20° to 100° C. Hydrogen wa generated on the outside of an iron tube by immersing th tube in a solution, and the volume of gas penetrating t the inside of the tube was measured. The rate wa greater for a unit immersed without electrical connectior than when the unit was used as a cathode, but in th latter case the greater the current the greater the penetr tion. The rate also increases with the temperatur Copper is not penetrated, but a coating of tin on the iro increases the rate. The effects of other conditions a shown.—*Journ. Franklin Institute.*

## MEETINGS FOR THE WEEK.

*Monday, June 7.*

Royal Institution, 5. (General Meeting).
Society of Chemical Industry, 8.
Royal Society of Arts, 8. (Cantor Lecture). "Alun nium and its Alloys," by Dr. Walter Rosenhain.

*Tuesday, June 8.*

Royal Photographic Society, 7.

*Wednesday, June 9.*

Geological Society, 5.30.
Institution of Electrical Engineers, 6. "High Frequen Machines," by M. Marius Latour.

*Thursday, June 10.*

Royal Society, 4.30. "The Thermo-elastic Properties Muscle," by A. V. Hill and W. Hartree. "The A sorption of Light by Elements in the State of Vapou by Sir James Dobbie and J. J. Fox. "Producti and Transmission of an Environmental Eff ct in *Sin cephalus vetulus*," by H. G. Cannon. "The Enzym of *B. coli communis* which are concerned in the I composition of Glucose and Mannitol," by E. C. Gr "Studies on Synapsis," by L. T. Hogben.
Optical Society, 7.30.
Institute of Metals, 8.
Institution of Mining Engineers, 11—5.

*Friday, June 11.*

Institution of Mining Engineers, 11—5.
Physical Society, 5.

*Saturday, June 12.*

Biochemical Society, 4.30.

# NOTICE.

OWING to the greatly increased cost of printing and paper, and the advance in the postal rates, we are most reluctan.ly compelled, for the first time, to increase the price of the CHEMICAL NEWS.

Commencing with the first number of Vol. 121, to be published on JULY 2, the price of the CHEMICAL NEWS will be raised from 4d. to 6d. (by post 7d.), and the new subscription price will be as follows :—

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3063, December 20th, 1918.
3064, January 3rd, 1919.
3066, January 17th, 1919.
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# NOTICES.

EDITORIAL.—All Literary communications, and Books, Apparatus, &c., for review or notice to be addresse[d to the] EDITOR.

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# E CHEMICAL NEWS

VOL. CXX., No. 3139.

## ON OILS FROM *HEERIA PANICULOSA*.

By C. F. JURITZ.

...llowing particulars with reference to the presence ...tile and fixed oils in the berry of a certain plant, grows to the height of twelve feet, is stated to abundantly in Zululand and is also found in the ...vaal, may be of some interest.

...ut three years ago M. L. C. von Wissell, of Ndumu, ...rn Zululand, sent me 40 lbs. of berries somewhat ...rrants in outward appearance. They averaged about mm. in size, were of irregularly ovoid shape, and ...d with a shiny hard black, crinkly pericarp, enclos... soft kernel. This kernel contained a yellowish ...tic fatty substance, solid in some cases and liquid ...ers.

...sender of the sample had noted that the berry was ...nous, and wrote that he had applied the oil to a festering sore with apparently good results, but ... drop which had accidentally entered his eye had ...ced slight irritation.

...plant producing these berries, said Mr. von Wissell, ...wn to the Zulus as *Isifiku*. The root and bark of ...ee, he further stated, contain a coagulable sap some... resembling the so called Japan wax, and, in addi... a dye or tannin.

...berries were identified as belonging to *Heeria* ...*ulosa* (Anacardiaceæ), a member of the Rhus or ...ch family. Some members of this family are useful, ...are acrid, some are poisonous. The mention of the sumach is sufficient indication of the relevancy of ...on Wissell's suggestion regarding the presence of a ...n; in fact, another species of *Heeria* (Klipbout), ...grows in the Somerset West Division of the Cape ...nce, is actually used for tanning. Moreover, the ...able fat usually miscalled Japan wax is obtained ...the sumach tree (*Rhus* sp.) cultivated in the far east. ...examination of the berries had previously been made ...e Chemist of the Government School of Agriculture, ...ra, Natal, who found them to contain:—

| | | |
|---|---|---|
| Moisture .. .. | 58·6 | per cent. |
| Crude oil .. .. | 11·7 | „ |

...arrival of Mr. von Wissell's parcel in this laboratory, ...erries were air-dried and two separate quantities were treated by ether-extraction, showing respectively ...per cent and 27·14 per cent of oil of a specific gravity .... Nine separate quantities of berries of 200 grms. were steam-distilled and yielded percentages of ...ile oil ranging from 4·47 to 6·07 and averaging 5·00. ...volatile oil thus obtained was found to boil at 69° C. ...r 755·9 mm. pressure. Its specific gravity was 0·823. ...heating it changed colour from a light to a dark ...w and on further heating decomposed. The above ...ts made it evident that a relatively small proportion ...e oil contained in the berries was volatile. The oil ...ined by ether-extraction was subjected to steam distil...n, and yielded 17·05 per cent of the volatile oil above ...red to, corresponding to 4·59 per cent in the air-dry ...ies. The residual fixed oil remaining after this dis...tion was thick and viscid, and amounted to 89·70 ...cent of the total oils extracted by ether, the 6·75 per ...increase being apparently due to absorption of oxygen by the non-volatile glyceride. The viscid residue was further examined and gave a saponification value of 17... The amount of crude glyceride yielded was 2·16 per cent.

A much larger quantity of the berries was subsequently directly steam-distilled and the volatile oil thus obtained was kept in a bottle for about eighteen months, at the close of which period—having undergone no perceptible alteration in the meanwhile—it was sent to the Director of the Imperial Institute.

In the interval a 10 lb. sample of the whole berries had been sent direct from the Transvaal to the Imperial Institute in order to ascertain whether the article is likely to acquire any commercial value as a source of oil. The berries were examined in the laboratories of the Institute, the volatile oil yielded by the pericarp being investigated separately from the fixed oil contained in the kernels. These were duly reported on by the Institute, and the results of the investigation, as well as the conclusions drawn therefrom, are abstracted below. The volatile oil from the pericarp amounted to 5·5 per cent of the latter. It was mobile and colourless and free from characteristic odours: the constants were as follows:—

| | |
|---|---|
| Specific gravity at 15°/15° C. .. .. .. | 0·832 |
| Optical rotation $a_D$ .. .. .. .. .. .. | +3·75 |
| Acid value .. .. .. .. .. .. .. .. | 1·6 |
| Ester value before acetylation .. .. | 4·2 |
| Ester value after acetylation .. .. .. | 14·8 |

These results indicate that the oil consists principally of terpenes, and as it has no distinctive odour it would be of little commercial value.

The fixed oil derived from the kernels was obtained in the Institute's laboratories by crushing the berries and distilling off the volatile oil. The yield of fixed oil amounted to about 30 per cent from the entire berries. This oil was viscous, clear, and dark brown, and had an aromatic not unpleasant odour.

The Director of the Imperial Institute in his report expresses the opinion that the fruits of *Heeria paniculosa* will not find a ready market in view of the many other superior oil-bearing seeds available. The fruits, moreover, cannot be easily separated into pericarp and seed or kernel, and accordingly there is no commercially feasible way of keeping the fixed oil and the volatile oil separate from each other. If the entire fruits (pericarp and seed together) were used for extraction of the fixed oil, the value of the latter would be diminished by the presence of the volatile oil, and the only way of preventing such a mixture would be to get rid, first of all, of the volatile oil by steam-distilling the entire berries, and then to obtain the fixed oil from the residue in the still, by submitting it either to pressure or to extraction by solvents, in which case the cost of treatment would be unduly high.

*Agricultural Chemical Research Laboratory,*
*Department of Agriculture,*
*Capetown, May 10, 1920.*

## MOLECULAR HEAT EQUATION.

By FRED. G. EDWARDS.

THE relation between the entropies of different substances is shown by G. N. Lewis and G. E. Gibson (*Journ. Am. Chem. Soc.*, Dec., 1917, p. 2354) to be $y = f(\log T - \log \theta)$, where $\theta$ is the temperature at which $y$ is one-half the constant 5·95; or, in other words, when the molecule contains two atoms in place of one. The degrees of freedom in a polyatomic molecule are $3 + m$, but for a monatomic molecule $m = 0$. Such a degree is merely the radial atomic expansion taking no part in radiation until $m = 0$. Between the values of $y = 2·975$ ($m = 2$) and $y = 5·95$ ($m = 0$) there is a point at which $m = 1$, and the position of this point will be at $y = 4·462$. The general equation is $m^x = k/\log T$,

TABLE II.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $m$ .. .. .. = | 36 | 8 | 6 | 4 | 3 | 2 | 1 |
| $n$ .. .. .. = | 36 | 8 | 6 | 4 | 3 | 2 | 1·33 |
| $y$ .. .. .. = | 0·165 | 0·743 | 0·991 | 1·487 | 1·983 | 2·975 | 4·4 |
| $S = \frac{1}{n}$ .. .. = | 0·027 | 0·125 | 0·16 | 0·25 | 0·3 | 0·5 | 0·75 |
| Pb .. .. .. | 5·798 | 11·012 | 12·72 | 15·82 | 18·79 | 24·0 | 38·8 |
| Ag .. .. .. | 10·488 | 21·58 | 25·10 | 32·29 | 38·77 | 51·0 | 85·4 |
| Al .. .. .. | 22·27 | 44·68 | 51·95 | 64·91 | 76·64 | 98·0 | 153·5 |
| C .. .. .. | 89·40 | 208·9 | 249·7 | 325·2 | 395·3 | 525·4 | 884·2 |
| KCl .. .. .. | 12·01 | 24·19 | 28·24 | 35·59 | 42·33 | 55·0 | — |
| NaCl .. .. | 14·29 | 29·09 | 33·96 | 42·88 | 53·22 | 66·0 | — |
| $H_2O$ .. .. .. | 52·34 | 115·77 | 137·1 | 176·1 | 211·4 | 277·0 | — |
| $H_2O$ .. .. .. | 73·22 | 173·25 | 208·1 | 273·0 | 332·7 | 446·2 | — |

where $x = 0·0698\ A^{\frac{1}{3}}$ and A = unit atomic or molecular weight. Temperature and molecular heat are given by abscissa T and ordinates $y$. Log T is the value of the constant $k$ at $m = 1$, and the asymptote to all curves is $y = 5·95$. The values of $y$ and also the freedom equations are given by $m = 5·95/y$, except where $m$ is less than 2. Values of $x$ and $k$ are calculated for particular equations (Table I.).

TABLE I.

| | $x$. | $k$. |
|---|---|---|
| Pb .. .. .. | 0·203 | 1·589 |
| Ag .. .. .. | 0·178 | 1·9316 |
| Al .. .. .. | 0·135 | 2·186 |
| Diamond .. | 0·115 | 2·9465 |
| K.Cl .. .. | 0·165 | 2·1876 |
| NaCl .. .. | 0·157 | 2·262 |
| Water .. .. | 0·1216 | 2·6574 |
| Ice .. .. .. | 0·1216 | 2·8827 |

Table II. gives absolute temperature for particular values of $y$ = molecular heat, calculated from the formula.

The constant $k$, which is the logarithm of a temperature, is a ratio respectively of the intrinsic pressure, the volume density, or the surface tension, but at present is only relative in the case of water. Dividing $k = 2·65740$ by $k = 2·8827$, the specific density of ice at 273° is obtained at 0·9218, which reduces to 0·908 on recalculating the unit size of molecule. Incidentally this tends to prove that the index $x$ is a function of atomic weight alone, and that Newtonian mechanics are adequate for the interpretation of molecular phenomena, so that the remaining receptacle for quanta is the ether as previously described. Below $y = 2·975$ $m = n$ = the number of atoms per molecule, or in the case of compounds the multiples of the unit molecule. The number of electrons is the inverse of $n$, and physically determines the size of the molecule or ion as the case may be. Where the temperature given by Table II. is above the critical temperature, the pressure is such that the density of a gas is equivalent to that of a liquid. As the temperature of both simple and double salts (the units are presently double) can be calculated at $m = 1$ with the value of the ratio of $k$ in terms of pressure, the heat of formation can be obtained for different temperature and pressures. The electrons per atom $= \frac{1}{2}$ at $m = 2$, and $\frac{3}{4}$ at $m = 1$, where $n = \frac{4}{3}$, so that if the metals are at the temperatures in any given column the contact potentials are zero. The potentials are thus measurable with variation of temperature from the points of thermo-electric inversion at constant volume. The Equation of State would contain the terms $k \pm a \log \theta$, where $\theta$ is the number of degrees from the critical temperature, and $a$ is an infinitesimal coefficient to make the ratio of $k$ equal to the critical pressure at the critical temperature. The equations for constant volume can be adjusted to the curves calculated by direct methods to any assigned degree of accuracy.

The values of $m = 1$ are omitted in the table fo pounds as they do not correspond with Doubling the size of the unit molecule, the spectively for KCl, NaCl, and water, are $x$ = c and 0·14288. $k$ = 1·983, 2·061, 2·697, and 2· T = 96·31, 115·1, and 498·0. The remaining the compounds thus require to be recalculated.

The graph of the variation of $m$ between $m$ = is a straight line of equation—

$$m = 4 - \frac{2y}{2·975},$$

and if this value be inserted for $m$ above $y$ = curves are uniquely determined. The value $m$ = 0 at infinity where the asymptote $y = 5·95$ meets At constant volume therefore the number of el never equal the number of atoms. Entropy, and voltage are determined by the number of el atom or molecule, and the reduction in the molecule by increase of electrons increases the the molecule in radiation, and therefore the te The use of the molecular-heat equation will mediate development in all branches of physic rapidly becoming an exact science.

The equation—

$$m = 4 - \frac{2y}{2·975}$$

gives the tangent at the point $y = 2·975$ to the hyperbola $ny = 5·95$. With monatomic electrons must be coincident with the atom the gas can have no molecular equation. Neo and argon thus contain one electron on altern The charged negative and induced positive ato dependent, so that the atomic heat is constant a 2·975.

The molecular equation will supersede som thermodynamic equations founded upon the that the number of atoms per molecule is a By simplyfying the equations to $m = 6/y$ and $m$ the error in $y$ is 5 per cent, and can be afterward

---

## A NEW CADMIUM VAPOUR ARC

By FREDERICK BATES.

THE necessity for increasing the intensity as w number of monochromatic light sources has been emphasised during the past few years. Un but little has been accomplished toward att objective. In 1906, the writer (*Bull.* of the Standards, ii., 239) directed attention to the imp this subject, and suggested that the so-called ye line (λ = 5461 A) of incandescent mercury adopted as the source for standardisation p

: work. The quartz-mercury vapour-lamp it advance in that it provided not only the n line, but several additional lines of lesser in- he best available methods of optical purification hat a monochromatic source is of little value ine is sufficiently removed from its immediate

namely, the direct radiation of the sun, is utilised, the necessary slit width, while less than that for any other known source, must still be such as to include a relatively large number of wave-lengths. The resultant wave-length or so-called optical centre of gravity of such a group of waves can be considered as a monochromatic light source

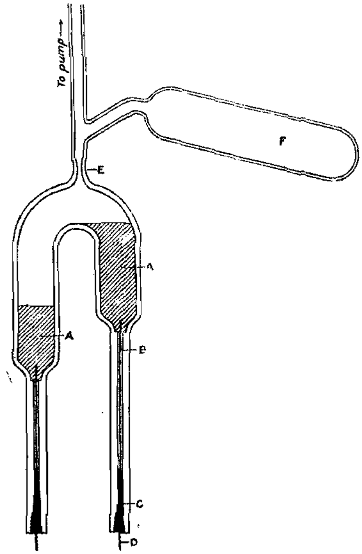



FIG. 1.

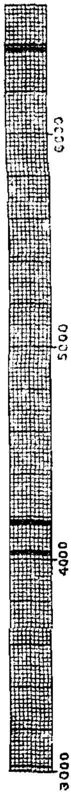



FIG. 2.

ars that nearly complete separation by spectrum is possible. If sufficient light to satisfy modern l and research needs is to be obtained from any urce it is necessary to use a relatively wide slit, onsequent probable inclusion of other wave-lengths mediate vicinity of the one desired.

the most intense of all known light sources,

in only a very restricted sense, and finds effective applica- tion in but few fields of work. It is especially unsuited to the study of phenomena which change rapidly with change of wave-length. The necessity for obtaining additional intense light sources is consequently imperative.

Among the possible sources which have been suggested is that of the rotating arc with *cadmium-silver alloy*

electrodes. This source gives a number of fairly intense lines sufficiently isolated from each other and fairly well distributed throughout the spectrum. The writer has carried out many experiments with this source, using an improved rotating arc. It was found impossible to maintain an arc sufficiently free from flicker to give satisfactory results.

Another possible source experimented with is the quartz cadmium vapour arc lamp, described by Lowry and Abram (*Trans. Faraday Soc.*, 1914, x., 103). This lamp is always unsatisfactory owing to two defects. It is necessary to have it permanently connected to an air-pump and to immerse the electrodes in water. If the cadmium in a vapour lamp is sufficiently pure, the adhesion between the cadmium and the quartz results in the destruction of the lamp upon the solidification of the cadmium. An improved form of lamp has been brought out by Sand (*Proc. Phys. Soc.*, 1915-16, xxviii., 94). In this type the tendency of the cadmium to adhere to the quartz walls is stated to be lessened by introducing into the lamp a small amount of zirconia in the form of fine powder. The cadmium is placed in a side tube connected to the pump, and the body of the lamp by a tube constricted to three capillaries for the purpose of filtering the metal. Additional filtering may be obtained by introducing a roll of iron gauze. Extensive experiments by the writer with this type of lamp have demonstrated that it is impracticable, provided a pure cadmium spectrum is desired. The method of filtering suggested is inadequate. The impurities introduced into the lamp by this method of filling undoubtedly have a tendency to prevent breakage, but effectively prevent obtaining a relatively pure intense cadmium spectrum. In order to eliminate all oxide and other impurities from the cadmium used in filling, it is necessary to carefully distil the cadmium into the body of the lamp. Upon allowing the lamp to cool, adhesion between the quartz and the metal takes place in spite of the presence of the zirconia. If the lamp does not crack upon the first solidification of the cadmium thin sections of the quartz are peeled from the walls by the contracting metal. Upon cooling a second time the lamp was invariably cracked.

Numerous experiments of varied character failed to overcome the constant breakage of the Sand lamp. Among the filling mixtures tried was a cadmium-mercury alloy. The percentages of the constituents were varied on a wide range. The introduction of the mercury is very effective in preventing the cracking of the lamp, as the alloy formed was so soft that no appreciable adhesion between it and the quartz resulted. It was found, however, impossible to obtain a brilliant cadmium spectrum under any circumstances. The vapour-pressure of the mercury being so much higher than that of the cadmium, resulted in the electric energy being almost entirely carried by the mercury, and the usual brilliant mercury spectrum resulted.

In view of the preceding facts it is evident that a serviceable brilliant cadmium-vapour lamp might be obtained by alloying the cadmium with a suitable element of lower vapour-pressure. Through the courtesy of Dr. W. F. Hillebrand, a quantity of the little known element, gallium, was obtained. The material was in a very impure condition, containing approximately 10 per cent indium. The freezing-point was below 22° C., at which temperature it was a liquid with a viscosity less than that of mercury. A study of the impure material was made by Dr. G. E. F. Lundell, who succeeded in obtaining the gallium in a relatively pure condition.

Crude gallium was dissolved in aqua regia, treated with sulphuric acid, and fumed to remove nitric acid. After dilution small amounts of lead sulphate were filtered off. The solution was then diluted, treated with hydrogen sulphide, and filtered to remove the hydrogen sulphide group of elements. The filtrate was boiled to expel hydrogen sulphide and treated with ammonium hydroxide. The precipitate was filtered off, dissolved, and reprecipitated three times to free it from zinc. The final separation from indium was based on the solubil gallium hydroxide in a solution of sodium hydroxide the insolubility of indium hydroxide in that reagent. sodium hydroxide separation was carried through times. The deposition of gallium was finally carrie by electrolysis of the alkaline solution as recommend Uhler and Browning (*Am. Journ. Sci.*, Fourth S 1916, xlii., 389).

The purified gallium had a freezing-point of app mately 30° C. This surprising fact has since been ve by the careful work of Richards, who has definitely this temperature at 30.8° C. (*Journ. Am. Chem. Soc.*, 131). Regarding the boiling-point of this elemen little is known. The few experiments which have made are in agreement that it is above 1500° C. property should make it an ideal substance for the pu in hand, provided it would alloy with cadmium. The experiment demonstrated that it united with cadmium the utmost ease. In fact, the addition of a few drc 10 or 15 cc. of cadmium completely changed the textu the latter, rendering it relatively soft and greatly red its tensile strength. Subsequently it was discovered upon distilling the cadmium from the alloy at a pre of 0·001 mm. of mercury, the minute quantity of ga carried through was sufficient to completely chang character of the cadmium and to prevent adhesion bet the cadmium and the walls of the lamp.

The type of quartz lamp used in the experiments is shown in Fig. 1. The total volume is approximately The electrodes consist of tungsten wires (B) entering the quartz capillaries. They are closed with lead seals si to the type described by Sand (*Proc. Phys. Soc.*, xxvi., 127).

In filling the lamp the cadmium containing 2 or cent gallium is placed in the bulb F. It is necessa maintain the pressure in the lamp and connections b 0·001 mm. of mercury with the exception of that due t cadmium and gallium, throughout the process of disti Owing to the fact that the volume of the lamp is relat small, the quartz capillary at E should be of such a le as to permit of sealing off in the shortest possible The flame used for this purpose should be small, and heating of the tube on both sides of the capillary shou prevented as far as possible.

The method indicated above, if carefully followed give a lamp with indefinite life. One of this type has in intermittent use for over a year and shows no sig deterioration. Should traces of oxide or stains due th appear during the process of filling, they can readil reduced by introducing pure dry hydrogen and hea The lamp may be started by heating with a flam vaporise the metal. It is in all cases advisable to ba current of air blowing upon the lead seals to keep cool. If the blast is allowed to strike the body of lamp the cadmium is condensed and obscures the The most convenient source of energy for operation i ordinary 110 volt lighting circuit, on which it will op continuously with a current as small as 3 amp., a drop of 14 volts across the terminals of the lamp. most satisfactory results, however, are secured with a cu of about 7 amp. and a drop across the terminals of a 25 volts. Under this condition a practically pure cadm spectrum of great brilliancy is obtained. The inte secured is apparently equal to that which would be obta were the lamp filled with cadmium alone. The map of spectrum of gallium given in Fig. 2 is interesting ( and Valenta, "Atlas Typischen Spektren"). The w lengths and intensities of the lines are given in Table this connection. It will be observed that there are but lines in the visible spectrum and that from practic 4200 A to 6400 A there are no lines.

When the lamp is operated at a temperature sufficie high to bring the quartz to a cherry-red colour, and t is danger of softening the lamp, several gallium l become faintly visible. The investigations of Uhler Browning indicate the possibility of two gallium l

A and 5359·8 A (*Am. Journ. Sci.*, 1916, xlii., 389). er, these lines, if present, are so faint at the highest ture at which the lamp can be operated that they be identified. The cadmium spectrum is thus d in a condition exceedingly favourable for those s for which an intense monochromatic light source spensable. No gallium lines are found between and 6400 A, and the gallium lines which are detect- ive so low an intensity that they are wholly negligible rimetric and other fields of work.

TABLE I.—*Visible Spectrum of Gallium.*

| Wave-length. A. | Intensity. |
|---|---|
| 3020·61 | 3 |
| 4033·18 | 10 |
| 4172·22 | 20 |
| 6396·99 | 8 |
| 6413·92 | 6 |

re are now available practically no dependable in- monochromatic red light sources. Any source to modern demands must permit of continuous operation minimum amount of attention and an absence of . The very pure red line ($\lambda$ = 6439 A) of cadmium to be the only possible source of sufficient intensity s region of the spectrum. It is believed that the um-gallium lamp will make this much needed source, ll as other lines of the cadmium spectrum, available any lines of endeavour.

e writer desires to acknowledge his indebtedness to . P. Phelps for valuable assistance in the experi- al work.—*Philosophical Magazine*, xxxix., No. 231.

## THEORY AND PRACTICE OF LUBRICATION: THE "GERM" PROCESS.*

ENRY M. WELLS and JAMES E. SOUTHCOMBE, M.Sc.

(Concluded from p. 272).

DISCUSSION (continued).

. C. V. BOYS, *in a letter to the Scientific and Indus- Research Department, writes as follows*:—

notice that the conclusions arrived at by Messrs. ls and Southcombe depend on the determination of rater surface tension, or rather of comparative values, e method of counting of drops. As a general pro- tion I very much doubt the conclusion that the num- of drops in a given volume is inversely as the surface ion, although it may be for some particular pair of ids or with a particular difference of density. The *e fact that the difference of density of the two liquids,* ch is one of the operative factors in determining the size, is not included in the statement and appears to *gnored is alone sufficient to raise very serious doubts*; quite apart from this the very complicated conditions ch determine the moment of instability or the breaking of a drop themselves appear to me to be incompatible h any such convenient conclusion. I say convenient clusion because if the method were correct in principle ould not be surpassed in ease of application.

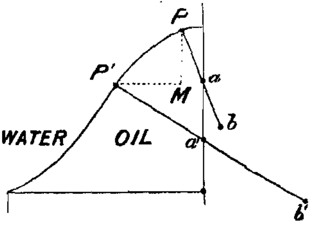
'*My object is not destructive criticism*, but a desire to pose an absolute method of determining the actual face tension of the water-oil surface in CGS or other inite units. *It seems to me of the first importance*, as conclusions of the authors are based on comparative sures of surface tensions, that the method of making measures should be above suspicion; further, mere parative measures, even if correctly comparable, are desirable than absolute measures.

* From the *Journal of the Society of Chemical Industry*, March 15, 0.

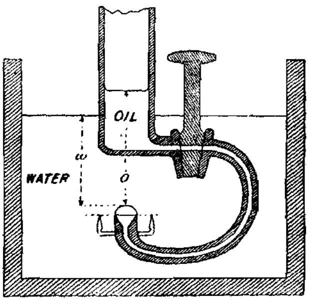
"Now, in all methods of finding drop size by allowing liquid to *enter the drop, however slowly, until it breaks* away, the hydrostatic pressure of the liquid at any level within the drop is unknown, but the following relations hold. *If* P *is any point on the surface of the drop (which* is a figure of revolution) and P $a$ $b$ a normal to the surface, then if the hydrostatic pressure in the oil at the level P exceeds that in the water at the same level by the amount $p$ dynes per sq. cm., $t$ the surface tension in dynes per cm. and $p$ are related thus:—

$$p = t\left(\frac{1}{Pa} + \frac{1}{Pb}\right)$$

$a$ is the point where the normal cuts the axis of revolution, and $b$ is the centre of curvature of the profile of the drop




at the point P. At a lower point P' the same is true, but here the *difference of pressure is less by the amount* (density of water − density of oil) × PM × $g$. All distances in cm. and $g$ in this latitude 981. As the drop grows there *comes a time when the differences of hydrostatic pressure* and the lengths Pa Pb in different parts of the drop are becoming incompatible, and instability results. The breaking depends on differences of hydrostatic pressure within the drop as compared with the surrounding water which determine the rupture. The actual hydrostatic pressure is not known, and its determination by elimination along the measurements of Pa Pb at a number of points,




P would be very tedious and inaccurate. In a pape twenty-seven years ago ("The Drawing of Curves by thei Curvature," *Phil. Mag.*, July, 1893, p. 81) I showed ho these forms may be drawn by a device there illustrate with far greater speed and accuracy than had hither

been possible, but all methods of determining surface tension in slowly growing drops which are allowed to grow until they break away have the disadvantage that there is nothing easily tangible or measurable except the number. In the first edition of my book on soap bubbles I showed a number of photographs, 23 in a circle, of a growing drop in a water surround, but the coming of instability led to movements of such rapidity even in these large and slow moving drops as to indicate how hopeless measurements at the critical phase would be.

"What I want now to suggest is that the surface tension should be determined absolutely by direct measures of the hydrostatic pressure within and without at the highest point of the drop. This point has the advantage that the contact here of the circle of curvature is a contact of the third order, and the radius of curvature $r$ can at this point be determined with an accuracy far greater than the $Pa$ and $Pb$ referred to above. The $Pa$ and $Pb$ become the same at this point, and thus the right-hand side of the equation becomes $2t/r$. The method of finding $r$ and $p$ and thence deducing $t$ will appear after the construction of the proposed apparatus is clear.

"This consists of a tube of the form shown, which may be held in a micrometer vertical slide (not shown) so that it may be moved gently through known very small amounts vertically. The tube contains some of the oil to be tested, and the stop-cock is used to stop all movement of oil when once it has reached the drop-forming surface and during the time that it is being immersed in the water and secured to the micrometer slide. The water is contained in a cell with plate glass sides through which all that is happening may be observed. The shape and radius of curvature of the drop will ultimately be determined by means of an enlarged photograph taken with a lens of, say, 4 in. focus, and in order that the scale of magnification may be known two points a definite distance apart attached to the drop end of the tube are photographed at the same time. The straight line joining them is exactly central. It would be advisable also to make the points at the same level as the drop end of the glass tube as will appear. All photographs of drops and other measurements made with a cathetometer are done *when the stop-cock is open and equilibrium is attained.* Then $w \times$ density of water $\times g$ is the hydrostatic pressure of the water at the level of the top of the drop; $o \times$ the density of the oil $\times g$ is the hydrostatic pressure of the oil in the drop at the same level, and this product is the greater of the two when the drop shows any convexity. They are equal when the oil surface is plane. Calling this difference $p$, and $r$ the radius of curvature obtained from the enlarged photograph, $p = 2t/r$.

"Now in order to make an experiment the tube is placed in position with the stop-cock closed, and is moved vertically until $w$ and $o$ are as nearly as possible inversely as the respective densities. Then, all being quiet, the stop cock is opened. The surface of the oil at the drop orifice should be very slightly if at all curved. The slide is moved until as far as the eye can tell the surface is plane. If the surface reflects light this can be done with very great accuracy. $w$ and $o$ measured at once give the density, and a thermometer in the water the temperature. Now the tube is raised a small known amount by the micrometer screw of the slide, and the oil surface becomes slightly convex, and the curvature is determined by an enlarged photograph. $w$ and $o$ may again be measured with the cathetometer, but the micrometer screw will give a more accurate measure, for it gives a direct measure of the lifting of the apparatus. This gives the increased effective hydrostatic pressure of the oil subject to two small corrections. (1) The water level falls by an $1/m$ part of the elevation, $m$ being known from the area of the free water surface and the area of the tube and stop-cock intersected by the water surface. The oil depth is ... height of the drop, which can be got from ... the drop and two points, and also by the ... due to the small content of the drop. ... with great accuracy, or with a ... time.

good cathetometer $w$ and $o$ may be directly measured ... time.

"A series of photographs and measurements of d... successively more developed give a number of valu... surface tension in absolute measure, and the consist... of these will give a measure of the accuracy with w... the determination is made.

"I am not sure what is the best diameter of the ... end of the tube. The authors have probably found ... already by experiment. The diameter has to do with ... possible development of the drop shape, and extr... either way give less convenient forms for the purpo... measurement.

"The above observations are directed solely to ... experimental operation of finding the oil-water su... tension. I am not discussing the propriety or utili... this determination in relation to journal friction.

"If the water and oil were absolutely immiscible ... uncontaminated either by the other it would be a m... of indifference whether a water drop were formed in a ... round of oil hanging downwards or an oil drop ... formed in a surround of water hanging upwards; the ... face tension would be the same, and the sizes and f... of the drops for the same $p$ would be identical. If, ... ever, as is probably the case, there is some degree of ... cibility and contamination, the conditions might well ... be the same, if so little water and much oil are diffi... materials from little oil and much water. If there ... difference, I do not know which measure would ... truly give the quantity that the authors seek to ... Further, I am not satisfied that there is justification ... using the water-oil surface tension any more than ... oil-air surface tension. However, the real object of ... letter is not to go into this question of justification, b... give the best help I can in a class of experiment in w... I have a good deal of experience."

## PROCEEDINGS OF SOCIETIES.

### SOCIETY OF PUBLIC ANALYSTS AN[D] OTHER ANALYTICAL CHEMISTS.

*Ordinary Meeting, June 2, 1920.*

Mr. Alfred Smetham, President, in the Chair.

A Certificate was read for the first time in favo[ur of] Mr. T. K. Ghose, B.A.

A certificate was read for the second time in favo[ur of] Mr. Udolphus Aylmer Coates.

The following were elected members of the Societ[y]: Misses Dorothy Gertrude Hewer, B.Sc. (London); Catherine Hawkins Johnson; Messrs. Harold Hall, F.I... Geoffrey Trelawney Bray, A.I.C.; Frank William Ge... King; John Herbert Stubbs, M.Sc. (Victoria), F.I.C.

Papers, of which the following are abstracts, were r...

"*The Estimation of Nitro-glycerin.*" By H. D... Richmond, F.I.C.

The hydrolysis of nitro-glycerin is discussed, and ... methods of estimation, one gasimetric and the o... alkalimetric, are given by the author, which he cl... yield satisfactory results.

"*A Study of the Determination of Potassium as Perchlorate.*" By R. Leitch Morris, F.I.C.

The author points out that when the process is prop... carried out the results are highly accurate, the ave... error not exceeding −0·1 per cent on pure potassium s... and there is an average error of +0·1 per cent in the ... sence of much sodium. Attention is called to the fact ... the wash fluid should not contain less than 97 per cen... alcohol after adding 0·2 per cent $HClO_4$. Exact de... of the method of carrying out the process are given ...

to temperatures. Quartz dishes are recommended, necessity for the removal of sulphates is emphasised. thor states that when Mg, Ca, Fe, or Ba are pre- y do not interfere, but when Ba is present barium will be found in traces during evaporation over a re.

*aratus for Evolution Methods of Analysis." "An d Form of U-tube."* By E. R. DOVEY, A.R.C.S.,

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## THE INSTITUTE OF METALS.

SIDENTAL ADDRESS, by Sir GEORGE GOODWIN, K.C.B., LL.D.

fficult for me to express fully my appreciation of our paid to me on being elected President of the e of Metals. I thank you for this honour, and I knowledge with gratitude the compliment to the Navy in the choice for a second time of the r-in Chief of the Fleet as the President.

e of the speeches recorded in our *Journal* reference to the fact that the Institute has been fortunate election of its officers. I am sure that we are all that the Institute is also to be congratulated on the ished men who have hitherto occupied the Presi- Chair. They have performed their duties with consideration for the welfare of the Institute, with and with ability; and it must be a source of atisfaction and gratification to them to note the se of the Institute, and the place that it has taken c estimation and in the counsels of the scientific ustrial world. The proud position that the Insti- w occupies is largely due to the work of the Past- nts, and, although they must be well satisfied with ilts of their efforts, they have set a high standard, ilt one for their successors to maintain; but it will arnest endeavour to follow their example so far as le to do so, and to justify your choice by furthering rests and purposes of the Institute to the utmost ower.

ostitute is also fortunate in having the services of aw Scott as Secretary. He is most zealous and gable in the interests of the Institute; he has a nd charming manner, which has done a great deal ith our path, and he possesses a mine of informa- ich is put to valuable use in Council and Com- meetings, and on many other occasions. Mr. Shaw as promised to give me full assistance during my of office, and that has made acceptance of the the easier; I feel certain also that, whenever I tendency to stray, his vigilance and experience will sure return to the right path.

Honorary Treasurer, to whom we owe much grati- r his services, is another sure bulwark and safe-

history of the inception of the Institute and its and work were reviewed in a very lucid and ing way by Prof. Carpenter in his Presidential s last year, and I am pleased to note that the s in membership is still continuing, but the import- nd services of the Institute deserve a more rapid expansion, and this I trust will be realised in the ture.

inherent purpose of our Association is to join r those interested in non-ferrous metals and -that is, metallurgical scientists, manufacturers, ers of these materials—in research, in investiga- failure, and application for the advancement of s of such materials. As one of the last-named t is appropriate that my remarks in this address be mainly confined to the users' aspect of our nd they will be given chiefly from the point of view naval engineer.

this is an important phase of the subject will be agreed, I think, when it is recalled that the British Navy is the largest individual user in the world of non-ferrous metals, excluding, of course, the precious metals of which we use practically none and the rarer metals where we are on common ground with many others.

The standards set by the Admiralty for most of the metals required by them have always been high, and to be on the Admiralty List for the supply of these materials has, I believe, always been regarded by manufacturers as a valuable asset. For reasons to which I will shortly refer, I am of opinion that that view is quite sound.

It has sometimes been suggested that it is somewhat arrogant for the Admiralty to insist on such high standards, that it is, to say the least, extravagant to decree that the best and the best only is good enough for the Navy; but I can assure you that, although we do not always require the best, when we do ask for the best it is because the best is absolutely necessary, and further, that if still better materials were available we should require them.

In warship design, offensive and defensive powers, speed and radius of action are all tactical factors which must be taken into account. Their relative importance varies according to the type of vessel and her intended service; but in all designs, once the separate values are allocated to these features, it is essential that the weight and space required for the propelling machinery should be as small as possible, consistent with the maintaining of the desired power and the desired degree of reliability and durability.

Anything that can be saved in this direction will react on the design of the vessel as a whole and lead to a smaller displacement and a higher speed, or alternatively, to reduced engine power and lower fuel consumption for the same speed; or, again, on the same displacement greater offensive or defensive powers or a larger radius of action will be rendered possible.

The machinery weight is, moreover, closely allied to the steam consumption of the engines at full power, and any reduction in this respect is reflected in the weight of the boiler and condenser installations, with their auxiliaries.

The standing problem that has been before naval designing engineers for many years—thirty or more—has therefore been the reduction of machinery weight, coupled with the reduction of fuel consumption and increased durability and reliability.

It was not always so; the machinery of our warships was, years ago, of very much the same type as that fitted in contemporary merchant ships—perhaps in some respects inferior to it. That was in the days when speed was not considered in the Navy to be of great importance, and when steam power was used chiefly for the auxiliary purposes of getting in and out of harbour or in calms. The pressure for advancement began when speed was recognised as an essential condition of naval warfare, and the never-ceasing demand since then for higher speeds, and yet higher speeds, has resulted not only in the enormously increased power of machinery for the fast-steaming war vessel which we now possess, but in a greatly reduced weight of machinery and in a high degree of reliability which could scarcely have been dreamed of in those distant days.

The design problem has also been complicated by the need for economy in the consumption of fuel at low speeds. This question involves not only the important one of expense, but also the power to keep at sea for prolonged periods. It is, comparatively speaking, fairly easy to design for a definite fuel consumption at a steady steaming power, as in the merchant ship; but when it is borne in mind that the enormous power put into our warships is for use on special occasions only, and that during a very large proportion of their service these ships are cruising at only, say, one-tenth of their full power, the remainder being kept as it were in reserve, it will be granted that it is not so easy to obtain the desired economy

under all conditions of service. Here, again, it is a matter of balancing the advantages of a reduced fuel consumption, with its attendant reduced running costs and increased radius of action, against the disadvantages accruing from the increased machinery weight and space necessary to realise the lower fuel consumption at cruising speeds.

Moreover, warships are for tactical reasons required to change speed very rapidly, the variation from low to high speed and *vice versa* being demanded frequently and in very short time. All this results in those racking stresses and strains, difficult to estimate and provide for in the design, but whose effects are so well known to engineers, and of which we have had trying experiences during the war.

With the ever-present claim for minimum weight it is not possible, even after taking advantage of the saving which attends the use of high-grade material, to put into the machinery of warships all that we desire, and warship machinery design is always a compromise. It has been expressively described by a writer indulging in alliteration as a "complex complication of compromises." These compromises offer a fruitful field for the talent of the critics, many of whom apparently find it hard to understand that limitation of weight, and that alone, forces the omission of features which they consider necessary and which the designer would otherwise have been delighted to include.

The position at present reached as a result of the cumulative endeavour during the last few decades is that in our latest battle cruiser we hope to obtain 144,000 shaft horse-power on a total machinery weight (including water) of 4750 tons, that is at the rate of 74 lbs. per shaft horse-power, and our most recent destroyers have over and over again developed over 28,000 shaft horse-power on a weight of 32 lbs. per shaft horse-power.

That such results have been obtained with due regard to reliability is proved by the steaming performances of our ships during the war. They have fulfilled to the utmost our expectations, and of these performances we may, I hope, be pardonably and justly proud. I think you will also probably join me in my feelings of pride in the officers and men of the engine-room departments of our ships who have so satisfactorily carried out the duties entrusted to them during this protracted war. To all of them is due the greatest credit for all they did and risked, and did so well.

But while expressing this appreciation of the patient and successful endeavours of the personnel afloat, it cannot be left unsaid here that others are also entitled to a share in the credit for the result achieved. Much has been very rightly said respecting the industrial effort during the war, and no one appreciates the magnitude and quality of that effort more than I do. I can only describe it simply as beyond all praise. It marked the unanimous application of the traditional patriotism of a great and liberty-loving race, and was, simply expressed, beyond all praise.

But the industrial effort could not have been made, however willing the workers—nor could the warships themselves have been produced—without the thought, research, and experiment concentrated on naval machinery design before the war. Many hundreds of minds had been at work for years prior to 1914 preparing for the task that threatened us, so that if and when the time of trial did arrive we should be ready to face with confidence all that could be brought against us. There is proof of this in the fact that nearly all the heavier fighting vessels that served the country during the war were designed and mostly delivered before the outbreak of war.

The preparation was a really good contest, and now that we know fully the nature and extent of the preparation by the other side, I submit that we can be justly satisfied with any comparison. Our steam machinery was superior both in type and in design, and also in most, but perhaps not in all, of the manufactured details. On the other hand, our heavy oil-engined propelling machi leaves us with further work to do in the future. In essential feature of weight we appear to be superic steam machinery and not far behind in heavy oil-engi In the latter the designing engineers of those oppose us apparently did not use to the fullest advantage properties of the excellent materials at their commanc

During the years of preparation, patient and thougt work had been done by a large number of engineer developing our warships' engines, boilers, and equipm step by step, inventing, designing, testing, and impro types and details according to the guidance of science experience. Naval engineers necessarily took a lea part, their experience being a very useful factor on acc of the wide extent of its field. Marine engineering m facturers and the associated makers of prepared mate most zealously and loyally did their best in helping endeavour. All were imbued throughout with the big degree of engineering enthusiasm.

Practical scientists, notably metallurgists and chen specialising in oils, assisted the good work with unriv ability to an extent for which the Navy and the cou must be for ever grateful. Auxiliary machinery desig and manufacturers simultaneously made progress kept pace with the necessities imposed upon them, playing the same thoughtful care and the same rea tion of responsibility as obtained in the case of t engaged upon the main machinery, the makers ap ciating to the full that the success of installations whole depended very largely upon their integral par the work.

It is to the men who took such a large part in the and devoted preparation that I wish to express grati to-day. Without their work we could not have had pride of place in the naval steam machinery that we have.

The successive steps that have led to this position be briefly reviewed.

It was, I think, in 1881 that forced draught was applied to naval boilers, and the results of its applica and the limitations of the boiler designs in use led stag s to trials of the locomotive boiler in its sev forms, and later to the water-tube boiler. This w time of trial indeed, with worries and troubles that rarely had an equal. This phase had perforce t endured and passed through; but the difficulties were bravely faced, and their solution yielded invalu experience to our personnel, and played an important in equipping them for their onerous duties during the It is a matter of regret that so many of the workers years in this field have passed away without seeing fruits of their labours in the water-tube boiler as we it in the Navy to-day.

Simultaneously with this development in boilers passed through a stage of intense reduction in en weight, by increasing the speed of revolution of the ciprocating engine. I think this was brought to its utn perfection in the light destroyer engines running at c 400 revolutions per minute, and in the engines of cruisers of the *Good Hope* class, developing some 15 i.h.p. on a single shaft. A grander sight than t engines running at full power it is difficult to conc and it was with some pangs of regret that engineers such engines pass away. But the sentimental must alv give way to the utilitarian, and the splendid realisatio Sir Charles Parsons' laborious endeavours for many y in the production of the steam turbine marked an e in naval engineering which, seized upon very quickly, turned to account and gave us a lead which has maintained to the present time.

As far as our information goes, there was hesit elsewhere to adopt the steam turbine for some years we had fully accepted it. Throughout we have n tained our lead, both in type and in performance.

For many years the thoughts of naval engineers been directed to the advantages of oil as fuel in connec

naval machinery. It was for some time used only
ı auxiliary to coal, but the experience thus obtained
the progress made in burning appliances was such
it was early demonstrated that it could be used as
sole fuel when the security of supply could be relied
ı. As soon as this matured, the combination of the
r-tube boiler with oil fuel and the turbine became our
iite policy for the Navy, and finally determined the
riority which we obtained. We were first in this field,
the designs developed by us have been adopted in
ciple by other navies.
'ithout steam turbines and oil-fired water-tube boilers
could not have had the steaming performances to our
it that we have recently had. I have not time to refer
ie many instances of these great achievements, but I
just mention the expedition of the *Invincible* and the
*xible* to the Falklands, and the satisfactory results of
voyage.
may be of interest to recall that these results are due
*largely to two of our members, to* Sir Charles Parsons
his introduction of the steam turbine as a highly
tical marine motor, and to my predecessor, Sir Henry
n, one of our Past-Presidents. Sir Henry was asso-
d with all these developments and improvements for
thirty years. He was quick to seen the advantages
inovations, was ready to assume the responsibility of
oducing them, however drastic they appeared to others,
dealt with all their initial troubles in a masterly,
tical, and resourceful manner. As I have previously
d many minds worked on the problems of naval
neering for a long period, but the outstanding credit
gs in bold relief to these two men.
ie mercantile marine is largely adopting the steam
ne, and although water-tube boilers, or at least most
s, are not likely to be popular just yet in that service,
thought is being devoted to their possible advan-
s in certain circumstances, and any information or
rience we possess which may be useful will readily be
e available for such purposes.
is gratifying to notice that the large sums spent on
l engineering, in preparation for the destructive work
'ar, *will probably be fully repaid to the nation by the*
t advances in general engineering which the peculiar
lems of naval design have stimulated.
though war-time does not afford good opportunities
levelopment in naval engineering designs, production
g at such time the paramount consideration, yet it
be remembered that the geared turbine with its great
ntages so established itself in favour in the early days
ie war that it was definitely adopted for all types of
hips, and was fitted in a very considerable number of
els during the war, the direct driving turbine being
ceforth abandoned for new ships. For the inception
iis type we have again to thank Sir Charles Parsons.
*the success of the material* and the excellence of
manship which made the adoption of gearing possible,
hanks are due to the metallurgists and the machine
makers who were closely associated with us in the
stages of its introduction.
iving endeavoured to indicate the history and inci-
e of our peculiar problems, I should like now to con-
briefly how these essential and ceaseless reductions
eight are effected. Changes in type bring about the
*pronounced reductions, but such changes are not*
ient. Many improvements are due to modifications
ie design of specific items of the installation or to
ianical devices and appliances which belong to the
ieer alone, but there are others in which we are all
erned and can take an important part. I refer to the
rials.
hen the type of machinery is selected for a given
and the general features of the design are decided
, the design in detail is proceeded with. This entails
ideration of the dimensions, and reduction in weight
ected by increasing the stress allowed in the material
r as such stresses can be estimated or calculated.

The so-called working stress is generally a pre-arranged fraction of the ultimate stress of which the material is capable, and the ratio of the ultimate stress to this calculated working stress is known as the factor of safety. In most of the structures and moving parts of the machinery it is well known that the working stress can only be approximately calculated, and although the adopted factor of safety provides for contingencies which may not unreasonably be expected to arise, and also for the margins for wear and corrosion and for the usual allowances for additional stresses due to wearing out of line and other ordinary engine-room casualties (and such can be provided for with reasonable accuracy), yet there is no doubt that the factor of safety ensures in a varying degree against the unknown and against the designing engineer's doubts of the continued reliability of the material and of its true nature and behaviour under prolonged and, in the Navy, very variable conditions.

In short, the factor of safety to a considerable degree *measures not only the unknown and uncalculable stresses,* but also the degree of suspicion or doubt of the material. In other words, if a large factor of safety is used, it often indicates that the designer does not know all that he would wish to know about the material; it often suggests also that the metallurgist cannot sufficiently relieve his mind of the doubts.

It is in this field that our three sections—the metallurgist, manufacturer, and engineer—can well work together, *if each knows as fully as possible the needs of the* others.

The more that can be brought into full light as to the structure, the stability of the structure, and other essential properties of the materials, the lower that factor of safety can be, with consequent reduction of scantlings and lighter machinery.

If this be accepted, it is at once clear that the Institute of Metals can take a large part, by itself and through its members, in assisting the development of naval engineering and other branches of engineering where light weight is the essential desideratum.

It must, however, be realised that the problems are *never ending; as soon as a particular object is reached* new demands arise, and very often the job has to be tackled afresh.

The materials used in engine construction are chiefly iron and steel, on account of their high strength and relative cheapness. In marine engines, and particularly in naval machinery, non ferrous materials are more extensively used on account of their greater resistance to the peculiar forms of corrosion associated with marine use. In certain cases such materials are used generally, on account of their better heat-conducting properties. Some of the purposes for which they are used in naval machinery may be indicated, as they are of interest in so far as they provide regions for investigation for the purpose of improvement, which are either being explored, or which can be cultivated, by the members of the Institute for our general advantage.

I propose to illustrate this remark by a few of the many examples that might be quoted.

Our most important use of non-ferrous metals is in condenser tubes, and as we have these tubes at present in the Navy, we are, I think, fully satisfied with what our manu*facturers, after years of patient endeavour, have given us,* except that we want just a little more freedom from seawater corrosion. The investigators working for the Corrosion Research Committee of the Institute are doing great work in this connection. They have already shown us how improvements may be expected, and the results of their labours are being turned to practical account. You will shortly have an opportunity of hearing their Fifth Report, which you will find, I am sure, is of very great value. When they have succeeded in enabling us to remove from our minds doubts as to the freedom from corrosion of our condenser tubes, we engineers will assuredly be under an everlasting debt of gratitude to them.

Following their suggestion, a set of tubes, pre-oxidised ler their system, was fitted in one condenser of a patrol sel for comparison with a similarly manufactured set ed in the other condenser without having been so ated. Unfortunately for the comparison, both sets of es have behaved themselves quite satisfactorily so far, that the comparison is of little positive value. As far our opinion is of interest, I may say that we believe in, l are strongly predisposed towards, the pre-oxidised es.

This trouble from corrosion of condenser tubes is the st annoying one experienced in the Service; it is noying because we feel we have got so near success, l also because of the serious consequences of even all leakages.

t has recently been recorded that the Grand Fleet was y much inconvenienced at times owing to leaky conser tubes; but it must be remembered that this cuts h ways, and that ships of all navies suffered from this There is sufficient evidence to justify the belief that portionately others had to put up with more inconience than we experienced.

We have recently obtained specimens of tubes from ne of the ships of the German Navy. Dr. Hudson has mined some of them and has given a very interesting ort, from which I have extracted some details for the rmation of the Institute.

very noticeable feature of the samples examined is most of the tubes are either tinned or lead lined. The ing of tubes was a common Admiralty practice years when the circulating water was outside the tubes, and as of material assistance in prolonging the life of the s. The external surface could be easily completely ed with tin, but such a complete covering is more cult to obtain on the interior surface of a long tube of ll diameter, even with the greatest care; apparently ild a small spot be left uncovered an intense action is up, greatly reducing the life of the tube. I suppose same sort of thing would occur with lead-lined tubes other troubles at the tube ends might reasonably be cipated. For this reason such tubes have not had h use in our Service, and have been totally abandoned many years.

We, however, have great faith in a suitable covering of ogeneous quality, provided it is complete, such as the oxidising method promises to be, and provided it will d the erosive effects of circulating water under condi- s of normal service.

the latest sample we obtained, from one of the est light cruisers, there is no such lining or coating, the tubes are practically of the British Admiralty com- ion with a very small quantity of iron.

he possibility of using tubes of composition different those in general British practice has occupied the ntion of many workers, and it is quite a legitimate It is well known to us that materials can be used h will be practically free from corrosion; but to all workers a word of warning may be useful, and that it freedom from corrosion is not the only requirement condenser tube. The tubes must not be too expen- The manufacturers must be able to draw practically and commercially, and they must comply several other conditions which are fully laid out, I , in the Admiralty specification, with which members tirly well acquainted.

addition, I would also advise prospective workers in ield to read Dr. Hatfield's recent paper on season ing, and reap the further benefit to be derived from sal of the ensuing discussion.

e second example I will quote is turbine blading. many years turbine blades were made of brass, which onvenient in manufacture. The peripheral speeds and quently the stresses were comparatively low, and on whole this material has given, and is continuing to good results in designs suitable for its use.

th the introduction of impulse turbine difficulties became apparent. They may have been due to the increase in the steam temperature attending the employment of a small amount of superheat or to increased stresses on the blades of turbines of this type beyond the ordinary centrifugal stresses, or to a combination of the two. The higher stresses can be met to some extent by increased scantlings, but as is well known the ordinary brasses fall off rapidly in strength as they are exposed to higher temperatures.

Phosphor-bronze blading was therefore introduced for the high-pressure end of such turbines, and with the higher peripheral speeds of impulse turbines of the geared types, the use of blades in which the root and blade are combined has been much extended for these designs.

Tests of phosphor-bronze as used for this blading have shown an ultimate strength of 23 tons per square inch at ordinary temperature, and 20.7 tons at 440° F. This is satisfactory as far as it goes, but a material is sought which, while yielding nothing to phosphor bronze in its other qualities, will give a higher tensile strength and safely permit of high peripheral speeds where this would be of advantage, or alternatively reduced blade scantlings with its attendant advantages in respect to the turbine weight.

Steel has been considered and, although a highly suitable material in most respects, it has not been considered acceptable owing to the known risks of rapid corrosion, under conditions almost peculiar to the naval service. The Ferranti method, in which a thin coating of nickel is drawn over the steel blade, is known to give blades which are in a satisfactory condition in a foreign cruiser after a number of years' use, and a few rows of such blades fitted experimentally in two torpedo-boat destroyers of our service have also proved satisfactory. This system appears, however, only suited to blades of uniform sections, and has not, so far as is known, been applied to the other types.

(To be continued).

## NOTES.

Royal Institution. — A General Meeting of the Members of the Royal Institution was held on the 7th inst., Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. The Special Thanks of the Members were returned for a Gift of £1000 in the name of the late Dr. Frederick Du Cane Godman, F.R.S., per Dame Alice Godman, D.B.E. Dr. Russell J. Reynolds was elected a Member. His Highness the Maharaj Rana, K.C.S., Bahadur of Jhalawar, attended the Meeting and signed the Register of Members.

Catalogues for Asia Minor.—With reference to the previous communication from the Department of Overseas Trade on the above subject, they further state that as the direct parcel postage service to Samsoun has been interrupted, it is recommended that United Kingdom firms who may have been unable to forward their catalogues or have had same returned to them by the postal authorities, should address them to the British Control Offices, Samsoun, under cover to the Commercial Secretary to the British High Commissioner, Constantinople, who will have them forwarded to their destination.

New Seed-oil.—The oil from the seeds of *Calophyllum inophyllum*, a hardwood tree of the Philippines, known locally as Palo Maria, has been examined with a view to its applicability to the paint industry, but the results are not satisfactory, and it is evident that it must be subjected to some special treatment to give it rapid drying properties. The oil is not serviceable for food as it contains a poisonous resin, to which the colour and odour are due. It is, however, used in its native regions as an application in skin affections. The fatty acids yielded by it are principally palmitic, oleic, and stearic, so that it would

serve well as a source of soap and glycerol.—*Journ. Franklin Institute.*

EXTENSION OF THE USES OF RUBBER.—£5000 IN PRIZES.—The Rubber Growers' Association (Incorporated) offer the following awards for ideas and suggestions for extending the present uses or for encouraging new uses of rubber:—One prize of £1000; three prizes of £500 each; ten prizes of £100 each; a sum not exceeding £1500 to be divided amongst the remaining competitors whose suggestions are considered to be of value, according to the relative value of their suggestions, but so that no competitor will receive more than £100. Suggestions must be practical and likely to increase the demand for the raw material. Ideas will be welcomed for the application in new directions of existing processes, methods, or manufactures, or for improvements or new processes which will facilitate or cheapen the production of rubber goods. Competent judges (technical and otherwise) will be appointed to investigate and adjudicate upon the suggestions received. All enquiries in connection with the Competition should be addressed to the Rubber Growers' Association (Dept. C.), 38, Eastcheap, London, E.C. 3.

THE INDUSTRIAL LEAGUE AND COUNCIL.—Manchester is the selected venue this year of the Industrial League and Council, 82, Victoria Street, London, S.W. 1, for the holding of their convention of employers and employed, and the event, which has been arranged to take place on Tuesday and Wednesday the 15th and 16th inst., promises to be as big and successful as any of the previous similar gatherings organised by the League. The emissaries of the League have for the past month been particularly active in the neighbourhood, and since the whole-hearted co-operation and support of the Rt. Hon. the Lord Mayor, Alderman Tom Fox, has been won to the cause, adherents are flocking in from all quarters, so that, in the course of the next fortnight, Manchester will be the centre of gravity to some of the most influential commercial magnates of Great Britain as well as prominent leaders and directors of the interests of Labour. From the point of view of the industrial welfare of the town one can regard with mingled feelings of interest and appreciation the fact that Manchester has been selected as the rendezvous for the holding of what must inevitably transpire to be an influential and all-important convention, since the Industrial League and Council has now assumed dimensions approaching international status. Its activities are being watched with the greatest interest by representatives of capital and labour in all parts of the world where problems identical to those prevailing in England are being encountered. Even the Hon. E. G. Theodore, Premier of Queensland, who, by the way, will figure among the speakers at the Convention in Manchester, a few days ago most ungrudgingly paid the League a very high compliment. He was present at a gathering of upward of 500 employers and employees held under the auspices of the League and Council in the Great Central Hotel, London, and in addressing the assembly said:—"I am rather impressed at the character of this great gathering, and it indicates to me that you have made some progress towards a solution of the great problem which is facing the whole world to-day." Being the youngest Premier in the world, and a selection of a Labour assembly at that, the people of Manchester will undoubtedly lay themselves out to listen with interest to the important issues which he will have to lay before them. Already many of the larger hotels are beginning to appreciate what the influx for the convention will mean, since the Midland, the Grand, and numerous others of the adjacent establishments are booked up for the period. It is significant also to find that the Manchester Engineering Council, which is the oldest body of its kind in existence in the Northern area, is cordially co-operating with the representatives of the Industrial League and Council in the district in making the arrangements for the Conference. It is to be held in the Town Hall, and the Lord Mayor has generously placed his parlour at the disposal of the League and Council while it is in session. It would, perhaps, not be out of place at this juncture to explain what are the objects of the Industrial League and Council. It sprung into being five years ago as a result of a few informal conferences which were held between well-known Labour representatives and big employers of labour to discuss problems which were bound to ensue as a result of conditions brought about by the war. The importance of promoting some definite organisation to help foster public opinion on industrial difficulties and find solutions which would be acceptable to all concerned, was immediately realised, and the sequence is that the League from this unpretentious beginning has developed into the vast and powerful organisation which it is to-day. Its Presidents are the Rt. Hon. G. H. Roberts, M.P. (late Minister of Food), and the Rt. Hon. J. H. Whitley, M.P. (Deputy Speaker of the House of Commons). The League, while steadfastly refusing to identify itself with any political party, also abstains from interfering in any way in industrial disputes, while at the same time is always ready to tender any advice or information its ramifications may have culminated in its acquiring. It strongly supports the principles of the Whitley Councils, firmly believing that if ever England is to regain its old commercial prestige it can more effectively do so through the medium of conferences of employers and employed, and mutual peaceful understandings which will bring happiness and contentment to all engaged in industry, than it can by any system of party strife or direct action. Hence the League is out to engender and promote the atmosphere of confidence essential to bring employers and employees together to discuss and settle their own differences, and the records of what it has already achieved in the various parts of the country where branches are in active operation are clearly indicated in the evidence which comes to hand of how those areas are slowly but perceptibly settling down under the more harmonious conditions which the workers and employers engaged therein have amicably brought about. It is therefore to be hoped that Manchester in the very near future will be able to produce an equally meritorious situation as a result of the ministrations of an effective branch of the League and Council in this area.

## MEETINGS FOR THE WEEK.

*Monday, June 14.*

Faraday Society, 8. (At Chemical Society, Burlington House). "Conduction of Electricity through Fused Sodium Hydrate," by Alex. Fleck and Thomas Wallace. "The Measurement of Electrolytic Resistance using Alternating Currents," by H. F. Haworth. "The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures," by John L. Haughton. "The Theory of Electrochemical Chlorate and Perchlorate Formation," by N. V. S. Knibbs and H. Palfreeman. "The Sorption of Iodine by Carbon," by James Brierley Firth. "The Electrolysis of Solutions of Sodium Nitrate using a Copper Anode," by F. H. Jeffery. "The Pressure Variation of the Equilibrium Constant in Dilute Solution," by A. M. Williams. "Description of Models Illustrating Form and Symmetry," by Miss Nina Hosali.

Royal Society of Arts, 4.30. (Indian Section). "The Enduring Power of Hinduism," by Sir Valentine Chirol.

*Tuesday, June 15.*

Mineralogical Society, 5.30.

*Wednesday, June 16.*

Institution of Electrical Engineers, 6. Discussion on Papers read on "Distribution of Heat, Light, and Motive Power by Gas and Electricity," and "Report on the Coal-Gas and Electrical Supply Industries of the United Kingdom."

Society of Glass Technology, 2.15. (At Sheffield).

# NOTICE.

OWING to the greatly increased cost of printing and paper, and the advance in the postal rates, we are most reluctantly compelled, for the first time, to increase the price of the CHEMICAL NEWS.

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THE CHEMICAL NEWS.

VOL. CXX., No. 3140.

## REMARKS ABOUT SOME PHOTOTROPY PHENOMENA.

By Prof. JOSE RODRIGUEZ MOURELO.

I HAVE previously studied some invertible changes occurring in different substances under the influence of direct light, such as the colour changes undergone by certain sulphides when exposed for a short time to an intense illumination. (See *Anales Soc. Esp. de Fisica y Quimica*. 1903, i., 346; 1905, iii., 40; *Archives Sci. Phys. et Naturelles*, Geneve, 1906, xxv., 15. On the same subject I presented a note at the Congress at Zaragoza in October, 1908, of the Asociacion Española para el Progreso de las Ciencias). To-day I persist in this matter, which, according *to my view, is an interesting chapter of photo*chemistry, presenting new facts and dealing with it in a more general way, always confining myself to inorganic systems, because I judge these are less known and studied. It is true that in these colour changes due to light are less frequent; either they involve a reversible phenomenon or signify another class of non-reversible chemical transformations. At present I intend to contribute to the enlightenment of a point referring lastly to the velocity change in systems which constitute special solid solutions, formed by active substances and simple diluents, always of the same nature. These changes are, at last, singular cases of a general fact, continually very variegated in appearance, and which come out in different organic combinations modifiable or changeable by means of the action of light, sometimes rapidly and sometimes slowly, but whose effects result finally in permanent or momentary and periodic changes, every day more abundant and of various nature.

Marckwald was perhaps the first some time ago to observe the colour changes undergone by some complicated organic substances belonging to the chinolcic group under the influence of light. It is a reversible phenomenon, rather singular and really not frequent. Those sub*stances, called fulgides by Stobbe, can be taken as standard for* this class of substances, which are of phenolic nature, having the property of changing colour, passing from orange to brown, when directly illuminated for a short time, and recovering afterwards in the dark *their primitive colour without undergoing as till now* observed any chemical change. (For more particulars see Stobbe's Discourse at the Bunsen Society, Vienna, 1908). This fact, according to its mechanism, is compared to a certain photochemical reaction discovered by Luther and Weigert, consisting in the condensation of two molecules of anthracene, forming dianthracene. This fact verifies itself only when the carbide is exposed to the influence of direct light, and it is curious to relate that in the dark the opposite phenomenon is produced and the anthracene regenerated in a regular way without any other modifications being observed; thus this reaction is considered to be a perfect photochemical one.

It must be mentioned that this most remarkable experiment of the dianthracene formation under the influence of light dates from 1905, at least such is the date of its publication (*Zeit. Phys. Chem.*, 1905, li., 297; liii., 385), and in 1903 I made known my first remarks about colour changes undergone by a calcium sulphide when exposed to light, concluding this to be a perfect reversible photochemical phenomenon. Up to the present I have no knowledge of any other phenomenon of the same kind observed in inorganic substances (*Anales. Soc. Esp. de Fisica y Quimica*, 1903, i., 346).

The number of analogous facts was never considerable, yet at times the study of the chemical influence of light received greater impulse. Not long ago, observations being amplified and new methods of production invented, the number of phototropical phenomena increased, especially concerning organic substances, and then sprang the need of grouping, holding the criterion of its own mechanism. So the existence of the few in number reversible phototropies is admitted, in which the colour change is accompanied and originated by chemical actions, more or less complicated, but always presenting the same character of reversibility. Other phototropies are called pseudoreversibles, and among these must be mentioned, on account of being well known, the changes of colour from red to green of ferrous oxalate in presence of light. These phototropies are with some basis considered as catalytical phenomena which I find related, according to their production, to some very particular photoluminescence phenomena (Luther and Plotnikow, *Zeit. Phys. Chem.*, 1908, lxi., 13).

Also are known irreversible phototropies, the most frequent, and in these the colour change necessarily implies a permanent and stable chemical change, which cannot be taken as a starting point for reproducing the initial system.

For the real photochemical reaction it is convenient to start from Luther's definition. According to this investigator they are originated in the light, and in the darkness the initial state is regenerated in such a way that the fact can be repeated at will. To this class belong the change of colour experienced by calcium sulphide when submitted to strong illumination, employing the daylight. Similar *signification have other colour variations which cannot be* attributed to surface oxidations of sulphurous masses, phosphorescent and sensible to light.

I must note down that although cases of phototropy, at least in the last stage, cannot be considered frequent in inorganic substances, they are not very scarce and show particular points in each case. To this point I can mention the transformation of the hydrate $SO_4Ni,7H_2O$ clinorhombical green emerald into the hydrate $SO_4Ni,6H_2O$ quadratical variety with blue colour, obtained under the action of sunlight, from 20 to 30. This fact has been recently doubted, and it was said to be due to an efflorescence phenomenon peculiar to some nickel sulphates. Notwithstanding, Marignac had observed ("Recherches sur les Formes Crystallines," 1855), when studying the dimorphism in the heptahydrate mentioned, that the transit from clinorhombical crystals to quadratical, with change of colour to blue and loss of transparence, takes place at average temperature without alteration in weight, and I myself have observed, and it must be confirmed, that with intervention of sunlight the reaction is accelerated in a large degree. Perhaps it is a case of irreversible phototropical phenomena conditioned by the passage of one crystalline form into another, which seems to be the most *stable and definite of the substances in question*, but no generalisation must be made. It is true that colour changes are accompanied by chemical changes or molecular alterations, but it does not imply they are always phototropical phenomena nor that changes in shade and colour due to light always signify essential metamorphosis when they are frequently secondary facts. It must not be forgotten that in certain systems (ferrous oxalate and atmospheric oxygen, for instance) light provokes only the pseudoreversible reaction, prolonged and hurried by the photochemical catalysators, as Luther and Plotnikow have termed them, and these can be substances of a very different nature ("Las Reacciones Fotoquimicas Seudoreversibles," *loc. cit.*).

The starting point of my investigations has been a solid system, binary, rather homogeneous, composed of two essential parts; one the diluent, always the calcium sulphide, and the other the phosphorogen of variegated nature. Sometimes the last was simply the impurities of

substances employed in obtaining the sulphide which, when pure, is not phosphorescent, neither affected by light nor changing colour at its contact. Two methods can be employed when using phosphorogen for diffusing it in the calcium compound mass. The first method consists in grinding the mixture for some time in a porcelain mortar, pulverising first and then sifting, adding sulphur, and re-grinding till a very fine powder is obtained. (With 30 per cent sulphur I always get good results). According to the products in view to be obtained, the first substances to be used can be common quicklime, that obtained by heating the nitrate or carbonate or that by reaction between ammonia or soda carbonate and a calcium salt, this coming from white marble, shells, and lastly more or less pure carbonates from Iceland spath, to white chalk, washed, and dried.

According to the second process, called impregnation process, the phosphorogen, a metallic salt, is employed, dissolved and diluted in water—(experience shows that nitrates are most effective)—and with this liquid the calcium carbonate finely ground is moistened, making a paste which is dried to 100°, stirring without stopping, and when dry mixed with sulphur. I have found it to be a very convenient practice to calcinate in an open crucible in the presence of air, and with high temperature the calcium carbonate impregnated with the active substance till conversion in quicklime for operating afterwards. (Thus are avoided the risks of heating lime powder in a covered crucible). When the question is only to observe phototropical phenomena in solid solutions it is not necessary in many cases to add substances acting as phosphorogen. The impurities of lime and light oxidation of the outcoming mass are sufficient for the production of the phenomenon.

Perhaps the phototropy phenomena studied by me is more general than it could be thought. For its demonstration I must mention this observation of mine. Frequently when exposing to light and air some calcium and strontium sulphides in order to impressionate them by direct and strong light, and to obtain the oxidation necessary to the phosphorescence, I have observed a change of colour at the mass surface when extended on a white paper leaf (*Comptes Rendus*, 1897, cxxiv., 1024). With diffuse light the mass colour is whitish or greyish; under strong light comes to a rosy colour, rather strong, and after four minutes arriving at its maximum; in the dark or diffuse light, yet in presence of air, the new colour vanishes and the mass recovers its original hue. I have also remarked that substances able to suffer the mentioned changes have earthy structure, and frequently they are neither phosphorescent nor luminescent or only weakly, excepting some calcium sulphides which possess a maximum luminescence and are impressionable.

Excepting the chemical composition and different methods of obtaining, and taking account of its phototropical condition only, I find some analogies regarding the manner of colour changes produced between the calcium sulphides obtained by me and the transformations of Stobbe's fulgides when passing into unstable products generating the photoanhydrides, but also in the simpler case of reversible changes of colour easily observed, employing short range light rays (Discourse at the Bunsen Society, Vienna, 1908). As phenomena and effects are, at least externally, identical and provoked by the same reagent, I think that the likeness is well justified, though between limits where permanent chemical transformations are not recognised. (Those in ferrous oxalate and atmospheric oxygen, for instance).

The transformation of anthracene into dianthracene and the inversed phenomenon subsequent, considered as types of perfect and totally reversible reactions, are thus represented:—

In the light
Two molecules system, $2C_{14}H_{10}$ $\rightleftarrows$ $C_{21}H_{20}$ dianthracene
In the dark.

In the same way, the fulgides of Stobbe, starting from orange without photochemical change coming to its total development and stopping at what might be called the reversible phototropical phase, we should probably get—

With short wave-length rays
Fulgide A, orange $\rightleftarrows$ Fulgide B, brown.
In the dark or with long wave-length rays.

Generalising this procedure or representative form of these facts and applying it to the phototropy of calcium sulphide in the forms observed by me, we shall have—

| System A. | | System B. |
|---|---|---|
| Calcium sulphide. White phosphorescent or not according to the cases. | To the light $\rightleftarrows$ In the dark. | Calcium sulphide. Rosy, whose tone deepens more and more. |

Perhaps the phenomenon answers, with regard to its intensity, to the absorption of certain dark photochemical radiations which get loose when the direct enlightment of the substance ceases, but after realising in its mass a reversible chemical reaction, not yet well defined but possibly of the same class as the two former and never very complicated, because at most it is a binary system in the case of a diluent SCa and an active phosphorogen in that of bismuth.

I have explained in the former studies already mentioned that the calcium sulphide which changes colour under the action of light could be grouped in two categories. In the first are comprised those phototropical and phosphorescent at the same time, and the second embraces those solely phototropical. It is not possible at the moment to establish more concrete distinctions, nor to affirm in a positive way what would become of products after heating some hours to strong red and slowly cooling the mixtures, from the reaction of which result the calcium sulphide. Notwithstanding, the examen of the nature of the first substances, temperature conditions, and constitution of the solid system resulting, give some data contributing to lighten the problem, and were it not so the circumstances mentioned acquire by themselves interest enough to be taken into account.

It must be remarked—and this is already a first relation to be noted between the two categories of substances—that pure calcium sulphides are never phosphorescent or phototropical. They are totally inert with regard to the influence of light, and I have so demonstrated by a sufficient number of experiments (*Archives Sci. Phys. et Nat.* Geneva, 1908, xxv., 15). Therefore are necessary prima substances obtained purposely, incorporated and diffusec uniformly in its mass, employing the methods already mentioned, viz., small quantities of metallic compounds of diverse nature which act as phosphorogen (0·001 grm of copper, bismuth, cobalt, nickel, or manganese is sufficient), when the impurities existing in the first are no available or sufficient, or when they are not able to form with the sulphur incorporated black or brown sulphides a the temperature of constitution of the solid active solu tions. (The presence of iron is very prejudicial, and one gets inert brown masses). This is a common conditio for the calcium sulphides of both categories already mentioned, and perhaps more necessary in those presenting with maximum intensity the photoluminescenc phenomena.

The temperature at which calcium sulphides ar obtained is less related to the phototropy than to th phosphorescence, because that is lost by heating and tha remains unchanged. Though I have concluded numerou and diverse experiments relating to this case, I have nc

been able to determine the law that rules the dependence between obtaining the temperature of substances under study and the change of colour phe omena when exposed to light, and have only in this way confirmed by means of new ones the results of former experiments, and in sight of the variability of this and other phenomenal conditions to establish its individuality, depending each time upon conditions of the moment, perhaps secondary to the formation of binary phosphorescent systems.

I tried to appreciate numerically the calcium sulphide phototropy, as I had demonstrated its constance and persistence in each of the specimens which presented it. The special mechanism of the fact appeared to me, being a sure basis for getting it, at least with a rational approximation.

I kept each of these phototropical sulphides in a well-closed flask and in a dark place for many days, and when rapidly brought before a strong light it is possible to observe with some practice the beginning of the colour change. First, is light rosy which accentuates rapidly, and after a short time without sensible differences between the specimens, whatever may be the method by which it was obtained, it grows to its maximum intensity, taking a violaceous tone, which does not penetrate in the substance mass, as the colour change is only superficial. Taken into the dark the inverted phenomenon is produced, and after four or five minutes all the specimens under essay recover their primitive colour. This experiment repeated many times and changing the *modus operandi*, I have been able to remark the same uniformity whichever were the methods of obtaining the phototropical calcium sulphides. The condition of being phosphorescent has no influence, although some of them reached maximum intensities and were excessively excitable.

Something must be remarked about the phototropical calcium sulphide, and it refers to its structure. Meanwhile, that of the only phosphorescent is, with some rare exceptions, granulous, and its mass more or less drossy like a magma of little grains strongly adhered; the structure of those which constitute my study is always earthy and can be easily disaggregated. The first when pulverised loses an important amount of its sensibility, and sometimes is totally annulled and not phosphorescent. The second maintain the capacity of changing colour even when ground to dust. On the contrary, the luminescence by autoexcitation is always of the whole mass and the phototropy is limited to the surface in immediate contact with light. Though at present I cannot fix up its nature nor venture any hypothesis about its mechanism, I think that we are in the presence of a direct chemical action of light and not of transient oxidations, because the phototropy of calcium sulphide can be obtained even in inert gases atmosphere, the only condition being that moisture and carbonic anhydride be eliminated.

Moreover, the phototropy phenomena produced by oxidation are limited and generally belong to the pseudo-reversible class. In those whose reversibility was studied by me I found it total, and it falls under the Luther's definition. So without venturing on too bold conjectures I am inclined to think that the new phenomena could be perhaps assimilated, in certain cases, to the photo-luminescence ones as they are produced; finally, in analogous systems, they have very similar characters, and above all are determined by identical conditions.

It appears demonstrated that in the system of solid phosphorescent solutions when impressed by light are provoked some reactions between the diluent sulphide and the active substance of phosphorogen, and to this reaction is due the absorption of luminous energy emitted in the dark, while the backward reactions take place more or less rapidly and the system returns to its primitive state. The mechanism of phototropy is no other, at least outwardly, and the difference lies in the fact that in one case light is emitted in the dark, while in the other it is a change of colour under direct light, and in both photochemical actions are perfectly reversible.

## THE STRUCTURE OF MATTER AND THE QUANTUM THEORY.

SUPPLEMENTARY NOTE TO PART I.

By F. H. LORING.

REFERRING to the scheme shown on page 183 of this Journal, April 16, 1920, there appears to be an irregularity as regards the disposition of the outriders for O and F.

The O F pair should be *odd* according to the other pairs on each side, which are *even*. Therefore, since F is itself *odd*, the outriders may be common to both elements, so that they are, as it were, shared between the two elements, and by giving the outriders the position shown below, *the table becomes quite regular*; the idea here being, that the outriders 1 and 3 are, as it were, common to both elements, but O usurps "1" and "3" (1 + 3), whilst fluorine usurps "3" only.

It will be understood that in reality many atoms and many corresponding outriders become involved, so that "1" and "3" merely represent, in the scheme, labels on bins containing such atom-parts, but there appears to be a partial interchangeability of these parts during mass production in respect of these two atoms.

$$\begin{array}{llllll} O & = 3 \times 4 + & \uparrow & & & 3 \\ F & = 4 \times 4 + & 1 & & & \downarrow \end{array}$$

Another question arises from the scheme of hypothetical outriders, namely, *are these quantities exactly whole-number sub atoms of masses 1, 2, and 3?* The multiplication table given does not necessarily answer this question, as it may only show the building up of helium out of hydrogen.

The above should be read as a note underneath the tabular scheme on page 183.

## BRITISH CHEMICAL STANDARDS.

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THIS standard, which is now available, has been prepared under the auspices of a body of analysts co-operating on the lines published in a paper in the *Journal of the Society of Chemical Industry* (Feb. 15, 1919), in order to meet a long felt need for a steel containing some of the principal elements found in high speed and other types of tool and alloy steel, and is probably the only standard of its kind available in Great Britain to-day.

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| Phosphorus .. .. .. .. | 0·027 |
| Manganese .. .. .. .. | 0·102 |
| CHROMIUM .. .. .. .. | 3·03 |
| VANADIUM .. .. .. .. | 0·798 |
| TUNGSTEN .. .. .. .. | 16·20 |
| COBALT .. .. .. .. .. | 4·73 |
| Nickel .. .. .. .. .. | 0·44 |
| Copper .. .. .. .. .. | 0·055 |

Since in several instances the presence of certain elements is entirely without influence on the determination

of others, this standard may be used to advantage for *making check tests side by side* with several different classes of steel, *e.g.* :—

*C*, *Co*, *W* in alloy steels generally.
*Si*, *S* in all steels containing W.
*P*, *V* in Cr-V or Cr-V W steels.

The standard may be obtained either direct from Headquarters or through any of the leading laboratory furnishers at a price just sufficient to cover the cost.

A certificate giving the names of the analysts co-operating, the types of methods used, and a detailed list of their individual figures will be supplied with each bottle.—C. H. RIDSDALE, F.I.C., N. D. RIDSDALE, F.C.S., Organising Headquarters, 3, Wilson Street, Middlesbrough

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## NOTE ON THE TITRATION OF CERTAIN CHLORIDES WITH SILVER NITRATE, USING POTASSIUM CHROMATE AS INDICATOR.

By H. W. BOLAM.

WHERE a chromate is less soluble than silver chromate, as, *for example, is the case with barium chromate, the titration* of the chloride with silver nitrate presents some difficulty in determining the end-point of the reaction. This difficulty can be overcome by adding potassium chromate in little more than sufficient quantity to precipitate the barium radicle and then titrating with standard silver nitrate as usual. If the operation be carried out in a flask, the formation of a faint brown tinge, which is not discharged on shaking the flask and its contents vigorously for a short time, shows that the reaction is complete.

*A weighed quantity of hydrated salt was dissolved and* diluted to a measured volume at 15° C. Ten cc. of this solution should use 28·53 cc. of N/10 silver nitrate; the volumes actually required were 28·56, 28·57, and 28·46 cc. respectively; mean = 28·53 cc. The method is applicable to other similar cases.

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## "VAPOUR-DENSITY" A MISNOMER.

By PHILIP BLACKMAN.

ACCORDING to accepted scientific definition we have that—

"solid" (or "liquid") density

= weight of unit (C.G.S.) volume of solid (or liquid)

$$= \frac{\text{weight of solid (or liquid)}}{\text{volume of solid (or liquid)}};$$

but—

$$\text{"vapour" density} = \frac{\text{weight of vapour (or gas)}}{\text{weight of an equal volume of hydrogen gas at the same temperature and pressure}}.$$

But—

$$\frac{\textit{the weight of a substance}}{\text{the weight of an equal volume of standard substance at } \textit{like} \text{ temperature and pressure}} = \textit{the specific gravity of} \text{ the substance.}$$

Hence it follows that to be consistent, what is now ... should be ... specific gravity," and if the term "vapour-density" is to be retained it should be represented by "a value equal to the weight of unit volume (any conveniently large volume to be taken as standard unit) of vapour or gas at standard temperature and pressure."

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## ELECTRONS AND CHEMICAL POTENTIAL.

By FRED. G. EDWARDS.

DR. VICTOR HENRI'S "*Etudes de Photochimie*" (Gauthier-Villars et Cie., Paris), dealing with the measured absorption of the ultra-violet and infra-red rays, and finally calculating the spectrum of ultra-violet absorption directly from the chemical constitution, marks an epoch towards the final solution of many physical problems. The further measurements, delayed by the war, of the relations between radiation and matter, with the data for the absorption spectra of any compound, will be eagerly awaited. Dr. Henri, like a general conducting a modern campaign, *is hampered by orthodox but obsolete or imperfectly-developed theories*, which have proved themselves effective in the immediate past. The electronic hypothesis of matter, despite successive reductions, still demands far too many electrons; the quantum theory cannot be physically conceived without a substantial ether; and the Boltzmann fallacy of entropy being an increase in disordered motion of the atoms is shattered by the mathematical fact that the limit of heterogeneity is homogeneity. The number of electrons required by Dr. Henri for the carbon compound *is* strikingly similar to $S = 1/n$ *of the writer's* "Molecular Heat Equation" (CHEM. NEWS, cxx., 277). Any excess or defect of electrons from the number due to entropy at any given temperature constitutes an electric charge which cannot be concealed by assuming an opposite charge on the nucleus, as each entropic electron is inherently the quasi-elastic cause of an induced positive charge on the atoms. The conclusions of Dr. Henri in relation to the position and movements of the electrons are vitiated by his evident concern to include the currently-accepted theories, but denying such necessity, some clear deductions as to the operation of the electrons can be made once for all:—

1. *Given the true graphic formula of any compound, the* single bond represents one electron between the respective atoms.
2. The double or ethylenic bond appears when this one electron is removed. The characteristic vibration is displaced towards the infra-red by the consequent increase of mass in the vibrator changing the speed of propagation and consequently the angle of dispersion. The three double bonds usually shown for the benzene nucleus do not exist.
3. A triple or acetylenic bond appears when a second electron is similarly removed from the same pair of atoms.
4. A complete wave-length of incident light reciprocating with one electron of a molecule constitutes reciprocal absorption and emission.
5. An infra-red half wave-length ($E = h\nu$) absorbed by a molecule, represents the addition of one electron.
6. An ultra-violet half wave-length ($E_1 = h\nu_1$) absorbed, represents the motion of an electron the distance of a *half* wave-length from one position in the molecule to another, and provides the mechanism of tautomerism.
7. *There is a similar number of ultra-violet* bands whose respective frequency is a large integral multiple of every respective infra-red band, the latter representing the total removal or replacement of an electron, but the former merely a re-arrangement of its position in the molecule.

Dr. Henri attempts to correlate Bohr's hypothesis (p. 52), ...

atomic. This becomes clear, with the aid of the above deductions, in the mechanism of the absorption of the ultra violet ray by the ethylenic group (p. 98) which is conditioned by the movement of an electron from one position in the molecule to another, to take the place of the double or ethylenic bond. The chemical potential of the molecules *is very strongly augmented by* the introduction of an ethylenic bond and represents a state of lability.

Only by the adoption of a true philosophy can the specialised sciences be correlated and the riddle of the universe solved. "The foundation stones of the material universe remain unbroken and unworn" so soon as it is proved that *electrons* cannot be abstracted from the atomic *nucleus.* When Dr. *Henri's work on the organic compounds* is completed, the position and motion of *every* electron will be indicated by his absorption graphs, and the mechanism of absorption is reciprocal with that of emission of light; or the transformation of the energy of absorbed ultra-violet rays into infra-red frequencies, emitting electrons, constitutes the photo electric effect, *while the reverse action constitutes phosphorescence.*

## THE WORK OF THE FARADAY SOCIETY, AND A BRIEF REFERENCE TO MICHAEL FARADAY.*

By Sir ROBERT HADFIELD Bart., D.Sc., D.Met., F.R.S.,
President of the Faraday Society.

As in addition to our own Members, we have a large number of visitors present to day, I thought it would be of interest to write a short account of the work of our Society, which takes its name from one of the greatest of the Scientific Immortals—Michael Faraday. I need hardly say how glad we shall be to receive an access to our Membership of those interested in the work we are trying to accomplish, which is not only that of covering certain ground not dealt with by other Scientific Societies, but also of arousing interest in the minds of the younger men in our great Metropolis and elsewhere with regard to Scientific developments.

I also take this opportunity of saying a few words about *Faraday, who devoted his life to Science, with but one* single aim—to advance its position in the world, and to benefit mankind without fear or favour to rich and poor alike. No monetary or selfish considerations ever entered his mind.

At the time I accepted the invitation of the Council in 1914, conveyed through my friend, Prof. A. C. Huntington, to *be your President, I was not in good health,* and the duties seemed to be far too great for me to undertake. I felt, however, that it was a special honour and privilege to be asked to follow in the footsteps of some of our great masters of the past—Kelvin, Swan, and others—so I accepted.

When delivering my Presidential Address in June, 1914, I *little dreamt that our Empire was so soon to pass* through a time of unexampled stress. Nothwithstanding the difficulties with which those five troublous years were surrounded, I am glad to say our work never relaxed, and I do not think we suspended a single meeting, Council, Committee, or General. Thanks to the willing help given from all hands, whether by the council, by the members, or by our secretary, Mr. F. S. Spiers, it has given me no little satisfaction to think that the younger men amongst us have been aided in their work by our Society and its gatherings.

My work with the Faraday Society has been a labour of love. The time is, however, coming when I am sure you must think it only right that another of your members should take my place as President. Let me add that I have only been too glad to give any help in my power, and its future will always have the warmest interest of my heart.

Our Society owed its origin in 1902, chiefly to a little band of workers who met together to advance the great cause of Scientific Knowledge. *It was founded on* February 4, 1903, at a meeting in the rooms of the now defunct Faraday Club, held at St. Ermin's Hotel, Westminster. Amongst its founders were Mr. Sherard Cowper-Coles, Mr. W. R. Cooper, Prof. F. G. Donnan, Dr. F. M. Perkin, Mr. Alexader Siemens, Mr. James Swinburne, and Mr. F. S. Spiers, our present Secretary, to whom we *owe a deep debt of gratitude for his indefatigable work on* behalf of our Society, and to whom there should be accorded a crown of laurels. To each of these Founders I have sent a special invitation asking them to be present this evening.

Our first President was Sir Joseph Swan, F.R.S., later Lord Kelvin, followed by Sir William Perkin, F.R.S., *Sir Oliver Lodge, F.R.S., Mr. J. Swinburne, F.R.S.,* and Sir R. T. Glazebrook, F.R.S. The objects of the Society as originally defined were to promote the study of Electro-chemistry, Electrometallurgy, Physical Chemistry, Metallography, and kindred subjects.

I venture to think that we are accomplishing the objects for which its founders set out, and that the Faraday *Society will continue to increase and flourish. It is,* however, very desirable that we should extend our Membership, and I trust a great effort will be made by every present Member to bring in at least another new Member, also that many of our visitors to-night will join our Roll-Call. Stagnation in any Society means final decay. If we fulfil a useful purpose, as we undoubtedly do, then the aim I have set forth of a large increase in Membership ought to be possible. In one important Technical Society in America I learn they have this year increased their roll-call by no less than one thousand new Members.

Our Society is honoured and recognised in the Councils of the larger and parent Societies. It has a seat on the Conjoint Board of Scientific Societies and is consulted along with other Societies on the special subjects with which we deal and are acquainted. The fact that the Royal Society has this evening granted us the privilege of *holding our Symposium in its historic building also shows,* I venture to think, that our work meets with the approval of this great parent body of Scientists.

*Nitrogen Products Committee.*—I will refer to one subject in which we gave a helping hand during the war—in fact it might be said that the Faraday Society originated this special research in this country, namely, that relating to Nitrogen Products, which mainly through our suggestion was taken up by the Munitions Inventions Board. My friend, Prof. Huntington, of King's College, worked in season and out of season to get the Government Department concerned interested. He finally succeeded in persuading the Munitions Inventions Department to appoint a Special Nitrogen Products Committee, who in their turn *were instrumental in establishing a Research Department.* As Mr. H. W. Dickinson, Secretary of the M.I.D., points out, so much spade work was done by the Department with regard to this subject that when at a later date owing to the submarine campaign the policy of the Ministry changed and it was decided to go to new sources for Nitrogen supply, the results of the research work and of the information gathered by the *Research Department* mentioned were ready to hand and enabled practical work on a large experimental scale to be commenced at once.

It should be added that the work was taken up for the Committee by one of our Members of Council, Dr. J. A. Harker, F.R.S., who was allowed by the National Physical Laboratory to assist in this important development, his labours being of the highest value. The country is greatly indebted to him for the untiring devotion he has shown in working out this special and important subject

* Read at the Symposium on "The Microscope," January 14, 1920, in which the following societies took part:—The Faraday Society, Royal Microscopical Society, Optical Society, and Photomicro-

to a successful issue. Our Council hope that before long they will be able to present a Report to us describing in detail the work carried on. The Report of the Committee itself is shortly to be published, and it will probably be one of the most remarkable documents in regard both to scope and matter that has been issued by a Government Department during those troublous times.

The work done, although not immediately made use of for war purposes, as the armistice rendered any held needless in this quarter, will, without doubt, bear great fruit in the future; in fact, the Nitrogen Factory, which was being started during the war, has already been taken over by a private organisation. It is therefore probable that the Nitric Acid required in this country for making explosives, dyes, and drugs will be produced synthetically in this manner.

*Symposia previously held.*—Since the formation of the Faraday Society, we have had approximately 330 papers presented to us, most of them fully discussed. During my own term of office—1914 to 1919—some 180 papers have been read, and, including the present one, there have been fifteen Symposia held, attended by considerably over 3000 Members and Visitors. The following shows dates and titles:—

| | |
|---|---|
| Nov., 1914. | The Hardening of Metals. |
| Oct., 1915. | The Transformations of Pure Iron. |
| Dec., 1915. | The Corrosion of Metals. |
| Mar., 1916. | Methods and Appliances for the Attainment of High Temperatures in the Laboratory. |
| Nov., 1916. | Refractory Materials. |
| Mar., 1917. | The Training and Work of the Chemical Engineer. |
| May, 1917. | Osmotic Pressure. |
| Nov., 1917. | Pyrometers and Pyrometry. |
| Jan., 1918. | The Setting of Cements and Plasters. |
| Feb., 1918. | Electric Furnaces. (Symposium at Manchester). |
| May, 1918. | The Co-ordination of Scientific Publication. |
| Nov., 1918. | The Occlusion of Gases by Metals. |
| Jan., 1919. | The Present Position of the Theory of Ionisation. |
| April, 1919. | Radiometallography. |

It is hoped that the present Symposium will be no less successful than previous ones. Many Members and others at home and abroad have expressed their thanks for the useful work done by our Society. We have also tried to give a helping hand and encouragement to the younger men in our midst. This has been one of the chief objects we have always had specially in mind. Let our motto be "Thoroughness," and we shall continue to flourish and do still better work in the future.

*The Work of Michael Faraday.*—Turning now for a moment to Michael Faraday, from whom our Society takes its name, I will a little later on refer to one of the descriptions of the Great Scientist, by Prof. John Tyndall, F.R.S., in his lecture before the Royal Institution in January, 1863, on "Faraday as a Discoverer."

De la Rive, the well-known French Scientist, in his "Notice on Faraday's Life and Work," Archives des Sciences de la Bibliothèque Universelle, October, 1867, stated that the number of Faraday's Memoirs from 1820 to 1855, all of these important, was almost incredible.

Faraday was born at Newington Butts on September 22, 1791, and finally passed away at Hampton Court on Aug. 25, 1867.

Tyndall said that it seemed desirable to give the world some image of Michael Faraday as a scientific investigator and discoverer. He regarded the attempt to respond to this desire, whilst a labour of difficulty in adequately presenting a history of this great man, as also a labour of love. However well acquainted he might be with the researches and discoveries of the great master—however numerous the illustrations which occur to him of the loftiness of Faraday's character and the beauty of his life—still to grasp him and his researches as a whole; to seize upon the ideas which guided him and connect them; to gain entrance into that strong and active brain and read from it the riddle of the world—was a work not easy of performance. As he was a believer in the general truth of the doctrine of hereditary transmission, Tyndall, who shared the opinion of Carlyle that a really able man never proceeded from entirely stupid parents—said that he once used the privilege of his intimacy with Faraday to ask him whether his parents showed any signs of unusual ability. He could remember none. His father was a great sufferer during the later years of his life, and this might have masked whatever intellectual power he possessed. When thirteen years old, that is to say in 1804, Faraday was apprenticed to a bookbinder in Blandford Street, Manchester Square; here he spent eight years of his life, after which he worked as a journeyman elsewhere.

Faraday was only twenty-two years of age when he obtained a position in the Royal Institution. His first contribution to Science appeared in the Journal of the Royal Institution in 1816, that is, in the publication known as the *Quarterly Journal of Science.* I thought it might be of interest to give the following summaries by Tyndall of (1) Researches by Faraday, and (2) Discoveries by Faraday:—

*Researches by Faraday.*

| | |
|---|---|
| First contribution to Science—Analysis of Caustic Lime from Tuscany .. .. .. .. .. .. .. | 1816 |
| Experiments on Sounding Flames .. .. .. .. .. | 1818 |
| Vaporisation of Mercury at Ordinary Temperatures | 1821 |
| On the Limits of Vaporisation .. .. .. .. .. .. | |
| Experiments on Alloys of Steel .. .. .. .. .. .. | |
| Vibrating Surfaces .. .. .. .. .. .. .. .. .. | 1829 |
| On the Quantitative Comparison of different forms of Electricity .. .. .. .. .. .. .. .. .. .. .. | 1833 |
| On the Absolute Quantity of Electricity associated with the particles or Atoms of Matter .. .. .. | |
| The Power of Metals and other Solids to induce the combination of gaseous Bodies .. .. .. .. .. | |
| Extra Current—The influence by induction of an Electric Current upon itself .. .. .. .. .. .. | 1835 |
| On Frictional Electricity, Induction, Conduction, Specific Conductive Capacity, and Theory of Contiguous Particles.. .. .. .. .. .. 1835 to | 1838 |
| Further Researches on Liquefaction of Gases—Establishing the fact that Gases are vapours of Liquids possessing very low boiling points .. .. | 1844 |
| Speculations on the Nature of Matter and Lines of Force .. .. .. .. .. .. .. .. .. .. .. | 1846 |
| On the Diamagnetic Condition of Flame and Gases | 1847 |
| On Magne-Crystallic Action and Lines of Force 1848 to | 1851 |
| Magnetism of Gases .. .. .. .. .. .. .. .. .. | 1850 |
| Atmospheric Magnetism .. .. .. .. .. .. .. | |
| Electricity of Gymnotus .. .. .. .. .. .. .. | |
| Source of Power of the Hydro-Electric Machine .. | |
| Regelation .. .. .. .. .. .. .. .. .. .. .. | |

*Discoveries of Faraday.*

| | |
|---|---|
| Two new Compounds—Chlorine, Carbon, and Iodine; Carbon and Hydrogen .. .. .. .. .. .. .. | 1820 |
| Alloys of Steel .. .. .. .. .. .. .. .. .. .. | 1821 |
| Magnetic Rotations .. .. .. .. .. .. .. .. .. | |
| Liquefaction of Gases .. .. .. .. .. .. .. .. | 1823 |
| Change of colour of Glass in Sunlight .. .. .. | 1825 |
| New Compounds of Hydrogen and Carbon .. .. | 1826 |
| Benzol .. .. .. .. .. .. .. .. .. .. .. .. | |
| Improvements in manufacture of Glass for Optical purposes. Afterwards the foundation of most important Discoveries, *e.g.*, *Magnetisation of Light* .. .. .. .. .. .. .. .. .. .. .. .. | 1829 |
| Peculiar class of optical deceptions—optical toy, the Chromotrope owed its origin to this .. .. | |

Magneto-Electric Induction — Tyndall says: "Greatest experimental result ever obtained by an investigator. The 'Mont Blanc' of Faraday's achievements" .. .. .. .. .. .. .. .. ..
Terrestrial *Magneto-Electric Induction* .. .. .. ..
Identities of Electricities—Static, Voltaic, Magneto, Thermo, &c. .. .. .. .. .. .. .. .. .. .. 1833
New Law of Electric Induction .. .. .. .. ..
Laws of Electro-Chemical Decomposition—Definite *Electro-Chemical Decomposition. Tyndall says:* "This Law ranks in importance with that of the Definite Combining Proportions in Chemistry"
Origin of Power in the Voltaic Pile .. .. .. .. .. 1834
Magnetisation of Light and the Illumination of the *Lines of Magnetic Force. In other words*, the Rotation of the Plane of Polarisation .. .. .. .. 1845
Diamagnetism or the Magnetic Condition of all Matter .. .. .. .. .. .. .. .. .. .. ..
Atmospheric Magnetism .. .. .. .. .. .. .. 1850

*Summary of Faraday's Work.*

I will also quote Tyndall's Summary of Faraday's work somewhat fully as it is indeed worth reading. It is a stimulus to each of us according to his light to go and try to do likewise, even if in a smaller and humbler way.

Tyndall says:

"When from an Alpine height the eye of the climber ranges over the mountains, he finds that for the most part they resolve themselves into direct groups, each consisting of a dominant mass surrounded by peaks of lesser elevation. The power which lifted the mightier eminences, in nearly all cases, lifted others almost to an almost equal height. And so it is with the discoveries of Faraday. As a general rule, the dominant result does not stand alone, but forms the culminating point of a vast and varied mass of enquiry.

In this way, round about his great discovery of Magneto-Electric Induction, other weighty labours grouped themselves. His investigations on the Extra Current; on the Polar and other conditions of Diamagnetic Bodies; on Lines of Magnetic Force, their definite character and distribution; on the employment of the Induced Magneto-Electric Current as a measure and test of Magnetic Action; on the *Repulsive Phenomena of the Magnetic Field*, are all, notwithstanding the diversity of title, researches in the domain of Magneto-Electric Induction.

Faraday's second group of Researches and Discoveries embraced the chemical phenomena of the current. The *dominant result here is the great Law of Definite Electro-*Chemical Decomposition, around which are massed various Researches on Electro-Chemical Conduction, and on Electrolysis both with the Machine and with the Pile. To this group also belong his Analysis of the Contact Theory, his Inquiries as to the Source of Voltaic Electricity, and his final development of the Chemical Theory of the Voltaic Pile.

His third great discovery is the Magnetisation of Light, which may be likened to the Weisshorn among mountains—high, beautiful, and alone.

The dominant result of his fourth group of Researches is the discovery of Diamagnetism, announced in his Memoir as the Magnetic Condition of *all Matter*, round which are grouped his enquiries on the Magnetism of Flame and Gases; on Magne-Crystallic Action, and on Atmospheric Magnetism, in its relation to the annual and diurnal variation of the needle, the full significance of which is still to be shown.

These are Faraday's most massive discoveries, and upon them his fame most mainly rest. But even without them, sufficient would remain to secure for him a high and lasting scientific reputation. We should still have his Researches on the *Liquefaction of Gases*; on Frictional Electricity; on the Electricity of the Gymnotus; on the Source of Power in the Hydro-Electric Machine; on the Electro-Magnetic Rotations; on Regelation; all his more purely Chemical Researches, including his discovery of Benzol. *Besides these he published a multitude* of minor papers, most of which in the same way illustrate his genius."

Tyndall adds that no illusion is here made to his power as a Lecturer. Taking him all in all, it will be conceded that Michael Faraday was probably the greatest experimental Philosopher the world has ever seen. The progress of future research will tend not to dim or diminish, but to enhance and glorify the labours of this mighty investigator.

Speaking with regard to my own lines of research, as *representing the Faculty of Metallurgy*, I may mention that Faraday, in his experiments on Alloys of Iron with other Elements, in other words the production of Alloy Steel, carried out in 1821 and 1822, showed that a remarkable inspiration evidently existed in his mind as to the *great future this line* of research work presented. Singular to say it is just about one hundred years ago that Faraday wrote several letters from the Royal Institution (in April and June, 1820), to his Swiss friend De la Rive, Professor of Chemistry, Geneva, in which he gave an account of *some experiments on Steel made by himself and Stodart.* The world's great technical advances during the last thirty years have been—and I say it unhesitatingly—in a large measure due to the introduction of Alloy Steels such as Faraday had in mind. As already mentioned, Faraday, with Stodart, started these researches at the Royal Institution, finally completing the experiments by sending his various mixtures to be melted at the Sanderson Works in Sheffield, this Firm being still in existence to-day. The specimens had to be sent by coach, the work being given to a trusty assistant who had to go down and see the experiments put in hand and completed. Beyond the work of Mushet this particular land of Research lay fallow for many years, in fact it was my own discovery and invention of Manganese Steel in 1882 which showed that the new world already indicated by Faraday was there ready to be explored. This exploration has rapidly taken place during the last thirty years, including the discovery and invention of Chromium Steel, Silicon Steel, Nickel Steel, Tungsten Steel, High-speed Tool Steel, Non-corroding, and many other types of Steels.

Almost as important was the fact that Alloy Steel necessitated special heat treatment, which again required *and called for the use of scientific methods for the deter*mination of temperatures, critical points, microstructure study, improved analytical methods, mechanical testing, hardness determination, observation of electrical conductivity, magnetic susceptibility, electrical resistance, *hysteresis effects, and other qualities.*

In conclusion, this Society is indeed honoured in being allowed to bear the name of so great a man as Faraday, whose work is still benefiting our Empire.

## BOARD OF TRADE ANNOUNCEMENT.

GERMAN DEBTS.

THE Controller of the Clearing Office (Enemy Debts) desires to warn the Public that attempts are being made by German agents or principals to obtain direct settlement or payment of their pre-war debts from their British debtors.

By the terms of the Treaty of Peace Order, 1919, it is unlawful for any person to pay or to accept payment of a debt coming within *the provisions of Article 296 of the* Treaty of Versailles, and communication between the parties interested as debtor or creditor is forbidden. Any person contravening this provision is liable to be proceeded against and punished as if he had been guilty of the offence of Trading with the Enemy. *Severe penalties are* similarly imposed by German Law on German nationals contravening this provision of the Treaty.

Persons or firms to whom overtures have been, or may be, made for settlement of pre-war debts, except through *the Clearing Office, are requested to immediately com*

municate full particulars to the Secretary of the Clearing Office (Enemy Debts), Cornwall House, Stamford Street, London, S.E.1.

British nationals who are creditors of German nationals in respect of pre-war debts, and who have not yet notified their claims to the Clearing Office, should do so at once, in view of the fact that the time limit fixed by the Treaty for notification expires on July 10, 1920.

British nationals, to whom official applications have been sent by the Clearing Office for payment of all debts whether above or below £50 admitted to be due to German nationals, should pay these debts forthwith: failure to do so increases the interest chargeable against the debtor and exposes him to the risk of payments of law costs.

British claims to the number of 34,802 were on the 15th ultimo notified to the German Clearing Office, and a further large number will be notified during the present month. As soon as the notification of the admission of these claims has been received from the German Clearing Office payment will be made by the Controller without further request by the British creditor.

## PROCEEDINGS OF SOCIETIES.

### PHYSICAL SOCIETY.

*Ordinary Meeting, May 28, 1920.*

Prof. Sir W. H. Bragg, F.R.S., President, in the Chair.

A discussion on "*X-ray Spectra*" was held. The discussion was opened by the President (here given in extract only), who gave a historical sketch of the development of the subject, describing the work of Moseley, de Broglie, Duane, Dersham, Overn, Comptar, Seigbahn, and others. He described what was actually found by an X ray spectroscope, viz., an angle depending on the *ratio* of the spacing of the atoms to the wave-length of the radiation. The precision with which this can be found is very high, being already greater than that with which either the wave-length or the spacing can be found separately. It is well, therefore, to adopt a definite value of the spacing for rock salt or for calcite, crystals in most frequent use, since subsequent revision of such values will only involve changing all wave-lengths in constant proportion. To determine the spacing we depend on a knowledge of crystal form, specific gravity, and of the mass of the atom. For NaCl Siegbahn finds 2·81400 Angström units; for $CaCO_3$, 3·027904. It is probably best to assume 3·0279 for calcite, and to refer all measurements to this for comparison.

The ionisation and photographic methods of using the spectrometer were then described, and instruments suitable for the two methods shown.

Photographs of spectra were shown, and various features, such as absorption edges due to the silver and bromine of the photographic plate, or to the material of the anti-cathode, or to substances passed through by the rays, which appear on the plate in addition to the spectrum lines were explained.

The features of the line spectra were then described, and the simple relationships between the wave-lengths of the K, L, and M series were pointed out.

Mr. Charles Darwin gave the following account of the theory underlying the production of X-ray spectra:—We are to consider the application of Bohr's theory to X-rays, and especially the work of Sommerfeld in this country. To recapitulate the theory, the parts of an atom move according to the laws of dynamics, but not all dynamical motions are permissible. There is a series of permissible states in which the atom can exist without radiating, the elements of the orbits being determined by quantum principles. Radiation occurs by the system passing with loss of energy from one permissible state to another, according to the well-known law $W_2 - W_1 = h\nu$ to determine $\nu$. Without any more definite idea of the structure we can get out a good deal about X-rays. First, Bohr's idea leads at once to the Ritz principle of combination, by which the sum or difference of frequencies is also an observed frequency. This is, in fact, observed in X-ray spectra, and hence the study of them can be brought down from that of the lines themselves to the energies of the initial and final states of each. It is convenient to have a word for these energies, and they are called levels. By the general study of the X-ray spectra we find that there is one and only one lowest level in the K region, *i.e.*, $W_K$ has a much larger $-ve$ value than for any other permissible state. In the L region there are two fairly near together, $W_L$ and $W_L'$, and a third and fourth (hitherto unexplained) called $W_A$ and $W_A'$. The next group of levels is called M, and so on. They increase rapidly in complication. Then we can obtain radiations of frequencies given by—

$$\nu(K_\alpha) = \frac{W_L - W_K}{h},$$

$$\nu(K_\alpha') = \frac{W_L' - W_K}{h} \text{ (a close doublet)},$$

$$\nu(K_\beta) = \frac{W_M - W_K}{h}, \text{ \&c.}$$

Again,—

$$\nu(L_\alpha) = \frac{W_M - W_L}{h}, \quad \nu(L_\beta) = \frac{W_M - W_L}{h},$$

and so on. All this follows without any more precise assumption about the natures of the permissible orbits. A further support to our explanation is given by the intensities. Suppose the level $W_L$ is more likely to arise *than $W_L'$ and that $W_L > W_L$. Then $\nu(K_\alpha)$ is stronger* than $\nu(K_\alpha')$, and it is of higher frequency. But as $W_L$ occurs with the $-$ sign in the L-series, we conclude that in this series the line of lower frequency will be the stronger. This is borne out by observation. So much for the general developments. To get any further more definite assumptions must be made about the structure of the atom. We therefore imagine that it is made up of rings of electrons round a nucleus. We call the innermost ring K, the next L, and so on. Perhaps K has 3 and L 8 electrons for the permissible position which has least energy. Suppose that a shock is given, say, by an *incident X-ray. Nothing happens unless the frequency is* such that $h\nu$ is energy sufficient to change the arrangement to another permissible position. If it is great enough absorption occurs. Now suppose we inquire what conditions are required to lift out a K electron. The L, M, &c., rings are full up, so it is no use trying to put it there. Therefore the minimum frequency which can be absorbed corresponds to $W_K$, the energy necessary to lift an electron right out of the atom. When this has occurred the K ring is short by one electron, and it proceeds to replace it. This it may do by borrowing one from one of the other rings. Say it comes from the L ring. Then the *subsequent energy will be $W_L$ instead of $W_K$, and so the* emission will be $K_\alpha$. If from the M ring it will be $K_\beta$. Thus the absorption takes place in one step, but the subsequent emission may be in several. This explains the fact that the absorption frequency is higher than the emission frequencies of the lines.

Dr. E. A. Owen referred to the four kinds of frequencies of vibrations associated with X-ray spectra. *In the case* of the K-series spectra there are (1) several emission frequencies, (2) one frequency such that when multiplied by Planck's constant the product is equal to the minimum energy the electron in the X-ray tube must have to produce *that emission series, (3) one critical absorption frequency,* and (4) one critical ionisation frequency. Moseley found

om the examination of the emission spectra of the lements that the square root of the frequencies was pproximately a linear function of the atomic numbers of he elements emitting them, the heaviest elements showing slight divergence from the linear relation. Duane, xamining the critical absorption frequencies of the lements from manganese to lead, found a similar relation rith a *similar irregularity in the case of the heavier* lements. Calculating the velocity of the electron in the : ray tube necessary to produce a given radiation from he quantum relation—

$$\frac{\frac{1}{2}m_0v^2}{\sqrt{1-v^2/c^2}} = h\nu,$$

e observed that the relation $v = v_0(N - 3/2)$, where $_0 = 0{\cdot}00678c$ was a more accurate representation of the xperimental results; the greatest variation in the value f $v$ given by this equation from that deduced from xperimental observations amounted to a little over 1 per *ent. The critical absorption frequency is found to exceed* he frequency of the γ-line in the emission series by 0·2 or ·3 per cent, and the critical ionisation frequency to be qual to the critical absorption frequency to within less han 0·1 per cent. In the L-series spectra three critical bsorption frequencies are observed, and *Duane finds that* ach a-line frequency is equal within experimental error o the difference between the K critical absorption freuency and one of the L-critical absorption frequencies. ssuming the same law to hold for all emission spectra ought to be possible to deduce the critical absorption requencies of other series.

*Some experiments on the measurement of the relative* ntensities of the a and βγ peaks reflected by different rystals were described. For crystals containing atoms hich do not selectively absorb radiation incident upon hem, the relative intensities of radiations of two nearly qual *frequencies should remain constant. If, however,* ne of the radiations is selectively absorbed whilst the ther is not, the relative intensities of the reflected beams ill be greatly altered; in fact, the measurement of the elative intensity of two radiations of nearly equal freuencies would serve as a method of determining the ritical absorption frequencies of atoms comprising the rystal, by comparison with a suitable standard of eference.

The method of measuring the intensity of a peak was hat employed by Bragg, by turning the crystal at a efinite rate from one side of the maximum to the other. his agreed *well with another method of measurement* which the ordinates of the peak were experimentally etermined and plotted and the area measured directly. he K-series lines of palladium and rhodium were mployed and reflections measured from the five crystals, $aCO_3$, $CaF_2$, $SiO_2$, S, CSi. No regular change in the atio of the intensities of the peaks with specific gravity *f crystal was observed, but in* both crystals containing alcium the ratio was higher than in the other cases. n the assumption that the crystal selectively absorbs he radiation, the high ratio for the crystals containing alcium could be explained if calcium emitted a radiation *f wave-length somewhere* in the neighbourhood of $\cdot52\times10^{-8}$ cm. This would have to be a radiation of he J series. At present there is no definite proof that his series exists, so that possibly the phenomenon might e due to another cause.

Dr. E. H. RAYNER asked the order of magnitude of the uantities $W_K$, &c.

The PRESIDENT replied that they were of the order $0^{-11}$ c.g.s. units.

Prof. FORTESCUE proposed a vote of thanks to the resident and the other speakers for their able survey of he work that had been done in X-ray spectroscopy.

*Prof.* RANKINE *seconded, pointing* out the value to eachers of these co-ordinated accounts of a particular ranch of physics at which they might not be working

## THE INSTITUTE OF METALS.

PRESIDENTAL ADDRESS, by Sir GEORGE GOODWIN, K.C.B., LL.D.

(Concluded from p. 286).

OUR remedy appears, therefore, to lie in a non-ferrous *material. Monel-metal has many attractions, but we* are not aware that the manufacturing and supply difficulties have yet been satisfactorily overcome, although it has been used on a small scale for the blading of turbine auxiliaries.

Dr. Rosenhain has kindly brought to my notice information bearing on his work in connection with processes of blade manufacture, and with the suitability of aluminium-bronzes for blading purposes. Simple castings have been made to his suggested compositions and worked up by one of the firms specialising in turbine blade manufacture into what appears to be satisfactory blading; opportunity is awaited to test it under actual running *conditions.*

As is well known, there are many aspects to consider in connection with the suitability of material for blading work, apart from the matter of strength; but it may be of interest to the Institute to learn that erosion, which appears *to have been serious in some shore installations,* has not yet troubled us.

With the increasing use of superheat, we shall require the assistance of metallurgists and manufacturers to give us materials capable of withstanding the high stresses, necessary with our limited scantlings, when exposed to high temperatures, and turbine blading will demand a *great deal of attention. In addition, it will be necessary* to review the work already done in investigating the properties of gun-metal and other alloys when exposed to high stress and high temperatures, and in all probability it will also be necessary to undertake several other new *and similar investigations.*

I wish next to refer to propeller blade material.

The propellers of our warships for some years have been universally made of manganese bronze, gun-metal propellers still existing in some of the old vessels. The practice of using expensive alloys has been criticised from time to time, but such special alloys are necessary for this purpose, as they possess the several qualities required better than other materials.

To obtain the best efficiency from a propeller of given dimensions, it is necessary that the blades should be thin and their surfaces polished. We should have some difficulty in obtaining thin blades in sound cast steel of the large dimensions required, and a polished surface in either cast or forged steel could not be maintained in sea-water. Forged steel blades have been fitted and tried in some of our smaller vessels, but serious practical difficulties *attended their use and they were abandoned many years* ago.

For some years a peculiar severe action had been observed in the fast-running propeller blades of our light craft for which a cause could not be assigned. The defects which developed were at first attributed to foundry faults, perhaps with some justification, but when this factor was surely eliminated the effects continued. The action was termed "erosive," but the location of the defects and the nature of the deterioration of material left no doubt that the action was not erosion as the term is generally understood in marine engineering. In order to *endeavour to find more truly the cause of this action a* committee of investigation was formed by the Admiralty, which consisted almost entirely of members of this Institute. Our late President, Prof. Carpenter, and Sir Charles Parsons took a prominent part in the consultations and experimental work, and with the confirmatory assistance of eminent mathematicians it was concluded that the action was due to enormous stress produced in local patches in the material set up by a sort of water-hammer action caused by the collapse of the boundaries of vacuous

were such that no material in practical use could stand the shocks, and the cure had to be found in quite another direction, *i.e.*, cavitation had to be prevented.

I am afraid metallurgists, through the medium of the propeller manufacturers, had been unnecessarily troubled by the Admiralty for some years in this matter, and the case is interesting, not only from the results obtained, but because it illustrates so well the advantage of bringing together the several classes of all those concerned in such investigations. However, the work that has been done is not without its value, and we hope it will prove to have been the means ultimately of giving us propellers equally suitable to those now in use but of a less costly material. To any intending investigators I would offer the same advice as in the case of condenser tubes, and that is, firstly, to warn them that there are many requirements to be met in the blade material of fast-running propellers transmitting high power; and, secondly, to advise them to make themselves acquainted with all these requirements and keep them all in mind throughout their experiments.

I now wish to refer to the case of bearing metals.

Very interesting papers were read and discussed at our last meeting at Sheffield on the subject of white metals—interesting because they showed that workers for different purposes were in the same field. To be quite candid, it is probable that the bearing metal problem has lost a great deal of the importance that formerly belonged to it, owing to the fact that the true principles of lubrication so long known but not utilised have now been applied in a manner which can properly be described as revolutionary. It has long been thought that the nature of the bearing metal itself was a minor matter, provided that the oil film between the rubbing surfaces could be maintained; and the problem before engineers for years has been how to maintain that film with the ever-increasing direct bearing pressures and rubbing velocities. Following the mathematical investigation of the problem by Prof. Osborne Reynolds some years ago, the practical solution of the problem has been effected by Mr. Michell in no uncertain manner. It has been adopted unreservedly in the Navy for the thrust blocks of all descriptions of engines with complete success. Although some difficulties have presented themselves in the application of the principles to marine journal bearings on account of the need of reversibility, they seem to have been overcome, and a design is in successful operation in two of the turbines of one of our torpedo flotilla leaders, aggregating 40,000 shaft horsepower on two shafts.

Some work of great importance, however, still remains for the metallurgist. We have had, not by any means many, but one or two failures, and the investigations that are in progress may indicate valuable improvements in our workshop methods of dealing with bearing metals. It is further to be borne in mind that, presuming it to be true that the material of the bearing is not of primary importance while the lubricating film is maintained and actual contact of the rubbing metallic surfaces is avoided, immense mischief may be done in a very short time should the lubrication fail, and to provide for such contingencies it is still considered eminently prudent by engineers to provide in bearing materials for such mishaps, and to this extent the problem of the bearing material remains as important as it always has been.

A final example of the use of non-ferrous alloys will be found in the oil-engine.

In developing the fast-running heavy oil-engines a limitation was set for some time to the piston speed, owing to the high inertia stresses consequent upon the weight of the reciprocating parts. This limitation has been to a considerable extent removed by the adoption of pistons of aluminium alloys, and it is probable that further developments in this direction can be effected when we are more fully aware of the properties of such alloys to withstand the effects of high stress and high temperature, and as they are developed in conjunction with engineering devices to give improved results in the matter of heat flow.

With the view of reducing weight we are further c sidering the use of lighter working barrels of the cylind by the adoption of non-rusting steel, and this appears experiments made in our laboratory to have been rende practicable by the use of piston rings made of copper-z alloy, shaped in the form of obturator rings.

I have endeavoured by means of a few typical examp to show the manner in which naval machinery has veloped, and may be expected to develop, in the future far as the interest of this Institute is concerned, and instances I have given show, I think, that all sections c co-operate to considerable all-round advantage.

There has already been a great deal of co-operation, l I have a feeling that it has been to some extent in t pairs. I know that manufacturers have worked w engineers, and very successfully; I know that the me lurgist has worked with the manufacturer, and I beli with equal success. But the metallurgist has not be brought into direct touch with the engineer as much as desirable, and if contact of this nature can be improv it will be for the good of engineering science and progre We have had already some experience of such co-ope tion. As examples, the work of Mr. Arnold Philip, Admiralty chemist and a member of our Council, a that of the National Physical Laboratory, in direct col boration with naval engineers, have been productive results of very great importance and value to the Navy. am also aware of the very great advantages that the A Service has obtained by the combined efforts of th engineers, metallurgists, and manufacturers.

As an example of the successful co-operation betwe the engineer and the manufacturer, perhaps I may be p mitted to refer to a matter which will probably be in its of interest to the Institute.

In the early days of the war much inconvenience w felt on account of the inability of the copper tube wo to produce sufficient tubes to supply the demand, not o for tubes to be used as such, but also for those required be cut up for shell-driving bands. The demand for sh bands became so great that it became absolutely necessa to arrange other means of obtaining them. The cuppi of copper sheets was resorted to, a shell-band bei obtained from the cylindrical cup or dish so formed, l the method was expensive on account of the large amou of material left in the base as scrap. An engineer offi of the Admiralty suggested that the base should annealed and pressed again to form another cup of sm diameter, the base of the smaller cup being again annea and cupped again, and so on. The idea was taken up a firm in Leeds, who adapted their existing presses f this purpose, and by following up the idea of anneali and cupping the bases succeeded in producing seve series, the most extensive of which was the production seven bands in series—viz., 12 in., 9·2 in., 8 in., 6 i 4·5 in., 3·3 in., and 2·75 in., with very little scrap. Th were not unduly expensive, although produced not qu so cheaply as the bands cut from pipes. This firm w highly patriotic motive passed on all their experimen information unreservedly to other firms, who simila adapted their own plant, and by this process no less th 49 million shell-bands were made, weighing in the agg gate 38,000 tons. The relief given to the copper pi industry was immediate and appreciable and grew, un eventually the bands made from the successive cuppi processes were greater in number and weight than tho made from drawn pipes, and when the process w established the pipe industry was fully able to meet t largely increased demands for normal purposes.

This example, beside being typical of the methods increasing production, also indicates than when the pr perties and possibilities of working metals are known a realised there are more ways of tackling a problem th the one which is the most familiar.

I have read and heard a great deal about the adva tages that must result from the application of science industry; it is of course true, but a large portion of it h

remained for a long time, and still remains, in the abstract and is not really applied. The reason is, I believe, because the user has not been associated as much as he should be in the necessary discussions; after all, it should be realised that the user is the final arbiter.

I have discussed this subject with several men of high standing in their respective spheres, and their views are in agreement with my own as just expressed. On the assumption that they are correct it has been arranged, with the full concurrence of the professional chemists and metallurgists concerned, that our naval engineer officers now and in future shall receive instruction in metallurgy, not for a moment intended to make them metallurgical experts, but to a sufficient extent to enable them to discuss their experiences and their difficulties on a much more equable basis than has hitherto obtained.

The ordinary duties of these officers have brought them into sufficient touch with manufacturers; the manufacturers have already availed themselves of the assistance that the metallurgist can give, and it is hoped that the instruction now being given to naval engineers will enable them to utilise for the good of the Navy, more directly than hitherto, the information that metallurgists may be able to afford them. But this entails also that metallurgists must also extend their system of education. If they are to take their share of the conjoint burden they must make themselves acquainted not only with the manufacturers' but also the engineers' requirements. For this purpose, and following on the lines I have indicated as being desirable for others, they must educate themselves and make themselves acquainted with the principles of engineering science in the particular sphere in which they intend to practise. For my part I would go even further and provide that in our system of secondary education some knowledge of fundamental engineering and metallurgical sciences should find a place in mechanical science training. In this I mean, of course, modern metallurgical science.

In our Institute there has, I think, been a tendency to confine the reading of papers very largely, and I think too largely, to the scientific metallurgical side. If my views of the functions of the Institute are correct, we should welcome also papers by manufacturers and engineers which may be descriptive not only of their views, but which will undoubtedly open out a considerable field for the work of others, to their mutual advantage. This applies not only to the Institute itself, but to the local sections. I will not trouble you with further particulars at present, but I am sure there is a vast field ready for exploration, and I do feel that there is much conjoint work that can be undertaken by all of us in harmonious co-operation, work of a fascinating and congenial nature in almost virgin soil, which work if vigorously applied cannot fail to result in rich harvests for universal benefit.

We must also bear in mind that others beside our Institute may be interested in our problems, in particular I may mention that petroleum experts can be consulted with much advantage when dealing with the combined problems that arise in the development of the internal combustion engine, and co-operation with them should be facilitated as much as possible.

The co-operation I have indicated is a matter I have very much at heart, and if I can do anything subject to your approval, during my term of office, to give effect to these ideas, I shall be very pleased. If it should tend to the advantage of the Institute I shall indeed be gratified, and feel that your confidence in me has not been misplaced.

### Thermo-Electricity Progress.

The following is an abstract of the May Lecture on "Recent Progress in Thermo-Electricity" delivered by Prof. Benedicks, Ph.D., of Stockholm University, before the Institute of Metals, on Thursday evening, June 10, 1920. Engineer Vice-Admiral Sir George Goodwin, K.C.B., LL.D., President, in the chair.

Prof. Benedicks first gave a short summary of his theoretical views upon the metallic conduction of electricity which explained many matters not made clear by the former electron theory. A consequence of this new theory was that one has to conclude that even in a single homogeneous metal thermo-electric currents do occur; hitherto such currents were believed to be produced only when two different metals were present. Prof. Benedicks gave a concise demonstration of the most important experimental evidence of the truth of this conclusion, utilising for this purpose various metals.

In liquid mercury it had been possible for him definitely to prove the existence of thermo-electric currents, thus disproving the negative results of previous workers. A consequence of what the lecturer termed his "homogeneous *thermo-electric* effect" was that there must exist the *reverse* effect, the "homogeneous *electro-thermic* effect," including as a special case the well known Thomson effect. The reality of this effect was duly made clear. A specially interesting demonstration was of a new rotating thermo-electric apparatus made entirely of copper and rotating in a magnetic field, the driving force originating solely from unequal heating (by means of a tiny gas jet) of thin strips of copper.

The point at which the new knowledge brought forward by Prof. Benedicks might have some practical interest lay in the possibility of reducing the thermal conductivity of metals by insulated sub division into fine wires without impairing the electrical conductivity. The demonstrations were carried out with the aid of a galvanometer kindly provided by the Cambridge and Paul Instrument Company.

## MEETINGS FOR THE WEEK.

*Wednesday, June 23.*

Institution of Electrical Engineers. 6. (Wireless Section). "Development of Thermionic Valves for Naval Use," by B. S. Gossling.

Geological Society, 5.30.

*Thursday, June 24.*

Royal Society, 4.30. "On some Rostro-carinate Flint Implements and Allied Forms," by Sir Ray Lankester. "A Re-examination of the Light Scattered by Gases in respect of Polarisation I. Experiments on the Common Gases," by Lord Rayleigh. "Influence of Temperature on the Rigidity of Metals," by A. Mallock. "A Study of Catalytic Actions at Solid Surfaces," by E. F. Armstrong and T. P. Hilditch. "Tidal Friction in Shallow Seas," by H. Jeffreys.

*Friday, June 25.*

Physical Society, 5.


## UNIVERSITY OF LONDON.

A Course of Two Advanced Lectures in CHEMISTRY entitled—(1) "Emploi des Métaux Ammoniums en Chimie Organique," (2) "L'oeuvre Scientifique d'Henri Moissan," *will be given by Monsieur P. LEBEAU (Professeur a* l'Ecole Superieure de Pharmacie, Universite de Paris) at King's College, Strand, W.C., at 5 p.m. on June 28 and 30. Chairman at first lecture, Prof. F. G. Donnan, C.B.E., F.R.S.; Chairman at second lecture, Prof. Sir William Tilden, F.R.S. The Lectures, which will be delivered in French, are open to the public without fee or ticket. Syllabus obtainable on application.

P. J. HARTOG, Academic Registrar.

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'HE CHEMICAL NEWS

VOL. CXX., No. 3141.

## PROPERTIES OF WOOD CHARCOAL.

By ALWYN PICKLES.

### I. PREPARATION.

:GETABLE charcoal has long been known to possess a ry complex internal structure. This complexity varies th the raw product from which the charcoal is made d also on the manner and treatments with which car- nisation is carried out.

The surface area of a small quantity of charcoal dust remarkably great, and hence its property of removing itter from solution or of adsorbing gases.

The internal structure causes the effect known as absorp- n, the importance of which is not yet fully appreciated. is a slower effect than the surface effect or adsorption, d, of course, varies with charcoal used, state of division, de of preparation, &c.

The following papers give some idea of the behaviour charcoals under various conditions.

*Preparation and Efficiency of a Cocoanut Charcoal.*

The starting point was raw cocoanut shell free of fibre. Heating carried out in earthenware crucibles, air :luded, by placing the closed crucible in an ordinary e fire, temperature about 900° C.

About every three hours the following data were tained:—

i. Apparent density.
ii. Ash content.
iii. Efficiency against $NH_3$ at 14° C.

Parallel experiments, using occasionally treatment of duct with HCl, were also done. Dilute acid was used, charcoal being cooled before adding. Sulphur com- nds were removed as $H_2S$ by this means.

n another experiment, air was allowed free access to charcoal during cooling.

During this work it was noticed that a charcoal, on nding, became more efficient against a gas. This y be due to sorption of moisture, but also to ntaneous disintegration of the charcoal. Internal tin must exist in the charcoal particles after heating, as in newly fused glass. This strain relieves itself, integrating the charcoal and increasing the available face.

Long heating, under proper conditions, will evidently rease the efficiency of a charcoal. Acid treatment pre- its friability and removes S as $H_2S$. The acid also solves a certain amount of ash. Ash content increases ough oxidation. The sudden increase in ash content r three hours heating is due to water and hydro- bons being expelled.

Cooling the charcoal in air increases oxidation very con- rably. Up to a certain point increased porosity might obtained, but ash increases so rapidly that absorption n ceases.

### II. DECOLORISING POWER.

Animal charcoal is largely used as a decoloriser in sugar glycerin refining, since its efficiency is higher than t of most wood charcoals. The war, however, saw manufacture of wood charcoal put upon a scientific is, with the result that birch charcoal dust is as efficient, or more so, as animal charcoal. As a decoloriser it s not require as high a temperature, and since its density (1·46) is about half that of animal charcoal, mechanical stirring is not needed to the same extent.

Coarse charcoal is not very efficient as a decoloriser, and though such charcoals as cocoanut and fruit stone are remarkable as gas adsorbers they are inferior as decolorisers.

As a rule, the more complex a compound in a solution may be, the more readily will it be removed by such a substance as charcoal. Coloring matters such as dye- stuffs and the unwanted compounds in raw sugar and glycerin are certainly very complex, and therefore readily removed by using charcoal.

In the case of the alkaloids we deal with compounds whose structure is often complex and molecular weight very large. They are adsorbed positively by charcoal to a considerable degree. and since alkali halides are negatively adsorbed the value of charcoal dust—birch dust say— becomes apparent in any salting-out process for obtaining alkaloids from the vegetable tissues in which they occur.

The following results in negative adsorption will there- fore be of interest.

### III. NEGATIVE ADSORPTION OF ALKALI HALIDES.

By negative adsorption is meant the removal of the solvent by the charcoal with resulting increase in the con- centration of the solution.

Birch charcoal dust was used at the rate of 20 grms. to a litre of $N/_{10}$ halide solution. Estimation was by silver nitrate—chromate method.

*Halide, per cent Increase in Solution Concentration.*

| | 10°. | 25°. | 45°. | 65°. | 85°. | 100°. |
|---|---|---|---|---|---|---|
| NaCl .. .. | 6 | 4 | 4·5 | 6 | — | 9 |
| KCl .. .. | 1 | 0·4 | 1 | 2 | 2·5 | 3 |
| $NH_4Cl$ .. | 2 | 1 | 2 | 4 | — | 9 |
| NaBr .. .. | 8·2 | 7 | 5·8 | 8·8 | — | 9·7 |
| KBr .. .. | 3 | 1 | 3·5 | 6·0 | | 12 |
| $NH_4Br$ .. | 2 | 2·4 | 2·6 | 4·3 | 7 | 10 |
| KI .. .. | 4 | 2 | 2·5 | 5 | 7 | 10 |

If shown graphically, it would be seen that as a rule 40° C. is the temperature at which negative adsorption suddenly increases. It is at this temperature that the interior of the charcoal is becoming opened out by the solvent action of the solution. It is very probable that the first removal of the water from the solution is by surface effect of the charcoal—true adsorption—and that as temperature rises this effect diminishes with the decreasing surface tension of water. Interior or absorption effect, however, con- tinues to increase and soon more than counterbalances the decreasing surface effect.

The conditions governing negative adsorption are very complex and no absolute criteria can be given. It is very probable that no one property of a compound determines whether that compound will be negatively or positively adsorbed by charcoal.

Compounds negatively adsorbed from aqueous solution are:—

I. Simple in structure. Compounds complex in struc- ture such as alkaloids and coloring matters are largely adsorbed and positively. It appears a general rule, that the more complex a substance is, the more will charcoal remove from its solution, *e.g.*—

| | |
|---|---|
| Na Cl | negatively adsorbed. |
| $Na_2CO_3$ | *slight positive adsorption.* |
| $Na_4Fe(CN)_6$ | considerable positive adsorption. |

II. Highly ionised, even in concentrated solutions.

III. Metallic element in the compound is very electro- positive. Silver nitrate and copper sulphate are simple in structure, and the former is very highly ionised in solution, but both are much lower in the electro-chemical series than the alkali metals.

*Data obtained.* (*Gas Volumes converted to N.T.P.*).

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hours heating .. .. .. .. .. .. | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 |
| Apparent density .. .. .. .. .. | 0·67 | 0·92 | 0·87 | 0·80 | 0·75 | 0·68 | 0·64 | 0·62 |
| Ash content, per cent.. .. .. .. .. | 5·90 | 10·4 | — | 7·1 | 10·4 | — | 13·75 | 14·70 |
| Vol. $NH_3$ in cc. absorbed per cc. .. | — | 7 ? | — | 17 | 33 | 46 | 60 | 70 |
| Vol. $NH_3$ per cc. acid treatment .. | — | — | — | 18 | 37 | 51 | 64 | 72 |
| Vol. of $NH_3$ per cc. air admitted .. | — | — | — | 12·5 | 16·7 | 18 | 15·5 | 14 |

IV. The metallic element is mono-valent. Silver is mono valent and agrees also with I. and II.; the property III. is absent.

V. The constituent ions of the compound have a high mobility. The silver ion has also a high mobility $5·7 \times 10^{-4}$ cm. per second at 18° C., while that of lithium is $3·46 \times 10^{-4}$ cm. per second. In most cases, however, positive adsorption is accompanied by low ionic mobility. The ions Cl, Br, I, have very high mobility. Complex ions have low mobility, their relative size making friction of some account.

## IMPROVED FORM OF McLEOD GAUGE.*

By AUSTIN BAILEY,
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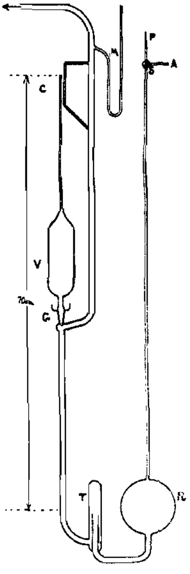
Any form of McLeod gauge is open to objections on the basis of the accuracy of the measured pressure, but since it has been almost universally adopted as a quick means of obtaining an indication of the pressure, any improvement in its form which makes it more easily operated is considered of real value.

The accompanying diagram shows an improved form of McLeod gauge. At S is a three-way stopcock which connects the mercury reservoir R either to the tube P, which is drawn into a fine point and open to the air, or to the tube A, which is connected to a water aspirator. At T is the usual air trap to collect any possible entrained air from R, but with this type of gauge such possibility is small. At G is a ground glass joint with a mercury seal which connects the compression chamber V to the rest of the gauge. M is simply a convenient comparison manometer.

The stopcock S should normally be turned so as to connect R to the aspirator through A. In this position V will be open to the pressure which we desire to measure. To make a reading the stopcock S is turned so as to open R to the atmospheric pressure through P. When the mercury in the comparison capillary has risen to a point level with the top of the capillary on V, the reservoir is closed by the stopcock at S and the reading is taken.

The advantages of this gauge are as follows: (1) The entire gauge stands on the table and the scale at C is at a convenient height to be easily read. (2) There is no possibility of spilling mercury or of having it rise too quickly into the compression chamber, since the rate of flow is governed by the size of the fine point at P and the rate decreases as the mercury rises in V. (3) The height from the lowest mercury level to the outlet tube being greater than a barometric height no mercury can run over into the apparatus that is connected to the gauge. The same is true on the side connected to the aspirator. (4) The apparatus has no rubber connections to contaminate the mercury. (5) The gauge can be used over a wide range of pressure by simply removing the compression chamber V and replacing it by another of different volume, but having the same size capillary. (6) Each compression chamber can be removed and accurately calibrated. There is nothing indefinite about the point at which the compression chamber becomes isolated from the rest of the gauge. (7) Since the compression chamber c[an] thus be removed and calibrated, it makes the gauge of p[ar]-




ticular value as a piece of laboratory apparatus for wh[ich] the student can devise his own direct reading scale.

* Abstract of a paper presented at the New York meeting of the American Physical Society, February 28, 1920.

## AGGREGATION AT THE MELTING POINT

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(Continued from p. 256).

*Third Section of the Curve* (*from* 387° *to* 932°).

This section of the curve extends from the melting p[oint] of iodine (387°) to the melting point of aluminium (93[2°]). The way in which the specific heat of aluminium va[ries] with the temperature is shown in Table VI. (Tilden).

TABLE VII.

| Element | M.P. | Melt. wts. | R. | $s = \frac{4·15 \times R}{M.P.}$ | Calc. at. heats (at M P ). |
|---|---|---|---|---|---|
| I .. .. .. .. | 387 | 635 | 5 | 0·0535 | 6·8 |
| S .. .. .. .. | 385·8 | 635 | 19·8 | 0·212 | 6·8 |
| In .. .. .. .. | 428 | 691 | 6 | 0·0582 | 6·6 |
| Li .. .. .. .. | 459 | 735 | 104·5 | 0·9402 | 6·6 |
| Se .. .. .. .. | 490 | 780 | 9·84—10 | 0·0842 | 6·67 |
| Sn .. .. .. .. | 504·9 | 802 | 6·75 | 0·0552 | 6·57 |
| Bi .. .. .. .. | 544 | 862 | 4·1 | 0·0311 | 6·48 |
| Tl .. .. .. .. | 575 | 914·4 | 4·5 | 0·0323 | 6·6 |
| Cd .. .. .. .. | 593·9 | 942 | 8·38 | 0·0582 | 6·54 |
| Po .. .. .. .. | 600·4 | 952·5 | 4·6 | 0·0316 | 6·54 |
| Zn .. .. .. .. | 692·4 | 1108 | 17 | 0·1014 | 6·63 |
| Te .. .. .. .. | 725 | 1167·8 | 9 | 0·0521 | 6·65 |
| Sb .. .. .. .. | 903 | 1512 | 12·5 | 0·0572 | 6·88 |
| Ce .. .. .. .. | 913 | 1534 | 10·95 | 0·05 | 7·00 |
| Mg .. .. .. .. | 924 | 1555 | 63·85 | 0·286 | 6·96 |
| Al .. .. .. .. | 932 | 1573 | 58 | 0·257 | 6·96 |

TABLE VI.

| ›solute temperature. | Specific heat. | Atomic heat. |
|---|---|---|
| 100° | 0·1226 | 3·32 |
| 200° | 0·1731 | |
| 300° | 0·2053 | |
| 400° | 0·2254 | |
| 500° | 0·2384 | 3·46 |
| 600° | 0·2471 | |
| 700° | 0·2531 | |
| 800° | ? | |
| 900° | ? | |
| 932° | 0·2600 ? | 7·05 ? |

From $\frac{M.P. \times s}{R} = 4·15$, R for aluminium is about 58 ł its melticular weight about 1572.

| | I. | Al. |
|---|---|---|
| Melting point .. .. | 387 | 932 |
| Melticular weight .. | 635 | 1572 |

$$\because \frac{387 - x}{\sqrt{635}} = \frac{932 - x}{\sqrt{1572}} = k$$

$$\therefore \; x = -563$$
$$k = 37·7$$

ľhe data in Table VII. is calculated from—

$$\frac{M.P. \times s}{R} = 4·15 \text{ and } \frac{M.P. + 563}{37·7} = \sqrt{\text{Melt. wt.}}$$

(To be continued).

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## ꞉OME CONTROVERSIAL NOTES ON THE DIAMOND.

By J. R. SUTTON, M A , Sc.D., F.R.S.S A., Hon. Memb. R. Met. S., Hon. Memb. S.A.S C.E.

### 1. *Spontaneous Breaking.*

ᴇ 40th Article of Religion in Kimberley affirms that ıt brown smoky-looking diamonds always burst to ꞉es. So profound is the faith that a *débris* washer who łs such a diamond which may have been out of the ᴇ for forty years—will at once race off with it to a ŀr, and will return triumphantly explaining how he fl›aded " it *before it burst*. In the same way a river ꞉er who finds such another—which may have been bled in the gravels of the Vaal for ages—will carry it about in his mouth, or inside a potato, trembling until he has transferred the risk of its exploding to some buyer.

The thought that naturally arises upon reflection is that surely the dealers know all about the risk, and that the 40th Article is altogether in their own interests.

In recent times writers on the diamond, almost without exception taking the 40th Article for granted,* have suggested how the bursting might come about. G. F. Williams attributes it to dryness, or to heat, which *may* expand hypothetical contained gases when a diamond is taken from a mine; Crookes favours the idea of decrease of pressure in the space surrounding the diamond; Wagner goes the whole distance, and claims that diamonds exhibiting the phenomenon of cracking or bursting are clearly in a state of great internal tension, like Rupert's drops.

Such explanations seem to be not specially applicable to brown or smoky diamonds; they would apply equally well to those of any other colour. Apart from that they are redundant for the reason that there is no indisputable evidence that diamonds—(1) burst (2) contain gas in sufficient quantities to set up great internal strain under the small range of temperature to which they are exposed in the ordinary way of mining (*Note A*); or (3) are in the condition of Rupert's drops (Note B).

In other words, diamonds have not been known to burst, and, besides, there is no certain reason why they should do so. This was a principal argument in "Kimberley Diamonds: Especially Cleavage Diamonds" (*Trans. R.S.S.A.*, 1918), and it is proposed to amplify it here, to answer some of the criticisms which have been launched against it, as well as to try to explain how the idea of bursting arose. Here the verb "to burst" is used in the ordinary sense as defined by the *Oxford Dictionary*:—"To *break suddenly, snap, crack, under violent pressure*, strain, or concussion. Chiefly said of things possessing considerable capacity for resistance, and breaking with a loud noise." That the verb has been understood in this sense, and not merely in that of a gentle breaking, disintegrating, pulverising, is evident, since "to explode" is used as its equivalent (Note C), and the behaviour of *Rupert's drops has been invoked by way of illustration.*

A friend writes me the following interesting remarks:—

> "I can form but little notion as to the extent to which your paper on Kimberley Diamonds may have reached the eyes of early diggers, of whom I was one as you know; but I am very sure that each one of such has been surprised at what you have written under the heading of "Spontaneous Breaking." To each this phenomenon is an established fact, and as such

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* " . . . sapiunt alieno ex ore petuntque
Res ex auditis . . . ."—*Lucretius*.

offering no possible ground for argument. The *stones most liable to break up were sharp-edged* octahedrons such as are most plentiful amongst the finds in the western portion of Kimberley Mine and (so far as I can recall) in Kimberley Mine only. In very many cases these stones had a more or less perceptible smoky cloud in one corner, and it became quickly known that such stones generally broke up spontaneously sooner or later. Various treatment was resorted to in the hope of saving, *e.g.*, embedding in potato, wrapping in oil-rag or cotton-wool, and no doubt others of which I have no recollection if I ever had knowledge, but I cannot recall any case of success beyond securing a sale.

"A case: W. found a 2½ carat, pure, sharp, glassy. T. saw and coveted the same to send to his wife, but funked a slight cloud in one corner. Eventually it was agreed that W. should hold the stone for three months, and if it were still sound T. would give £30 for it. The time passed, the stone was sound, and the sale was completed, and the proud T. put it with its pill-box full of cotton-wool in his pocket. Next morning I overtook T. on his road to work. His face *was long, his brow was puckered.* 'Look here,' quoth he, and produced the pill-box. 'This is the diamond I bought from W.; on going to bed I put the box on my dressing table; I awoke startled from my first sleep, lit a candle, opened the box, and look what I found.' I looked—cotton-wool and splinters! This case about mid-1872.

"Another case: I was buying diamonds in partnership with J. at this time. B. was in an office across the street. I happened to be alone when in came C. 'What will you give me for this?' 'This' proved to be a rather kidney-shaped smoky lump of 14 carats. 'What do you want?' 'Fancy stone! I want £10 a carat.' 'Give you *bort* price, 10s.' 'Rats' (if not more so). Talk. At last I offered 20s. as a spec.—it *might* not burst. 'That your best? Then I'll go to B.' Stone in hand he started across, I carelessly watching. He stopped suddenly, looked hard at his hand and turned back: 'All right old man, I'll take your offer; give the cheque.' 'Just let me look at the stone.' It was flawed through and through though still holding together. The above was as *near to seeing the catastrophe* as ever I went, and would have been near enough to convince me had I doubted. This about 1874."

It will be observed that the writer of the above letter considers that only Kimberley Mine diamonds were liable to burst, which limitation would still leave us without an explanation why there are broken diamonds (brown, yellow, and colourless) in other mines. Also, that W. held the suspected diamond without mishap for three months before T. bought it. Now, when one asks believers in the 40th Article why diamonds do not burst in the De Beers sorting office, the answer commonly given is that they burst beforehand in the mine as soon as their matrix *is disturbed—a quite reasonable argument if it had any* tangible basis.

Another critic tells me that a diamond once broke (he does not say "burst") to fragments in his mouth, and that he had a very bad time before all the sharp pieces could be got out—which is scarcely consistent with the belief that diamonds kept in a wet place will not burst.

Heddle—writing from hearsay, of course, like the rest—about 1877, gives quite a different version of the story:—"The cleavage of certain of the African diamonds is so eminent that even the heat of the hand causes some of them to fall to pieces. Such diamonds, generally octahedra, may be recognised by a peculiar watery lustre; they are called plate diamonds."

*2. Observations and Experiments.*

Some of my own observations and experiments bearing on the question of broken diamonds may be of interest:

1. A broken Koffyfontein diamond of good of about four carats, and one-half the size of th whole stone. There was a hole in the midd fractured face containing small pieces of foreign chiefly black. Held in a strong light under mag a tiny crack, transverse to the fractured face, made out in the vicinity of the hole. A sharp jer thumb and finger broke the specimen through th easily as a match can be broken. Some apoph penetrated the crack. It is a fair inference *original diamond crystallised, and broke,* ab mineral inclusion. The half examined was in so a state that merely dropping it on the table m broken it. Anyone overlooking such a crack easily might, and putting such a diamond awa tossing it in its paper envelope or pillbox int would find it broken the next day. And the would be quoted as another proof of the hu diamonds. Koffyfontein diamonds, it may b show more tendency to crack in two direction angles than do the diamonds from the Kimberl perhaps because of their prevailing irregular sha

2. Mr. Scott Ronaldson was good enough to a *dull brown Kimberley Mine octahedron* recov old *débris* which was seen to be slightly cracked bought it. Later it split in twain, showing the had crystallised about a smaller octahedron of similar colour and appearance, though of differen tion. Here again there is no need to invoke The case is just the same as those mention previous paper, namely, the unequal expansion traction of enclosure and inclusion.

In the De Beers collection there is a specimen from the same process, half a diamond with an o projecting from its broken face. The corre detached half has not been found. The p octahedron is *remarkable in having rough edg* Vaal River diamond.

In my own collection is a beautiful little specimen in which a cup-like shell of diamond (o original size) holds fast an octahedron. There dication of what filled the space between the inne outer diamond. There is a better specimen i Beers collection, a white octahedron penetrating of another, the second being attached to a c *shell like the previous one. Between the cup a* clusion is a yellowish foreign matter containi grains. Portions of diamond shells are ofte The original whole shells evidently held inclusio as large as themselves, then broke and the incl out. In some analogous cases inclusions hav holes through opposite faces of diamonds, leavin diamond beads.

Sometimes portions of such shells are found c a material not unlike cement in appearance. specimen whose dimensions are 6·5×5·5×2·5 shell being no more than a mm. thick. The gravity of the specimen is 3·56, indicating *material than diamond, though softer—possibly* containing some impurity. Fragments of round mens are occasionally found in which the cemen transparent diamond are in alternate layers like of an onion. Whatever the nature of this ceme up more strain than the thin diamond shells (Note D).

3. Some experiments were made with a cloud Wesselton diamond of about three carats weig flawed and somewhat strained internally, with of increasing the strain or extending the cracks experiments consisted of heating the diamond i tube in the flame of a spirit lamp, and of boil water. The result was negative, and to all ap the diamond is in the same condition now as it w it was experimented upon many months ago.

4. A nice rounded octahedron from Dutoitspan, three-quarters carat in my collection had a

lightly flawed smoky corner—just the sort of specimen to :xplode *spontaneously according* to the 40th Article. It was heated in the test-tube until the glass became soft, and was then placed under the receiver of a good air-)ump, and subjected to a considerable exhaustion of air. The flaw *may* have developed slightly under this drastic reatment.

### 3. *Deductions.*

The generalisation here proposed is that owing to the mall coefficient of expansion of diamond almost any inlusion will set up a state of strain *in a diamond sufficient* t times to cause breakage under robust treatment. Many f the broken diamonds in the De Beers production may ave fallen to pieces in the mining operations before they eached the sorting office. This is not an admission, of ourse, that they have been smashed by the machinery, or broken diamonds are found in the matrix: the hypobesis is that they are ready to break up, and that the nining operations, by shaking them up, help them to do o right out.

*Fundamentally there is no difference between the* pontaneous breaking of a pure colourless crystal diamond ontaining an inclusion and that of opaque or clouded iamond. In the former case there is a relatively large orce concentrated at one place, and causing a definite plit there; *in the latter the distributed particles and* nely-divided colouring matter set up many small strains which, acting together, cause disruption of a similar sort ) the pulverisaion of the blue ground when this is xposed to the air.

*The terms "bursting" and "exploding," therefore, must* e regarded as exaggerations of a simple tumbling to ieces. Opaque diamond will often break up quite easily. Wesselton black bort, when on the sorting tables, is iostly in fragments, or otherwise so much cracked as to : easily broken. From outside appearance there is more idication of bursting (as the term has been defined above) ı a colourless diamond containing an inclusion than there in any clouded stone. But no early digger has ever iggested the extension of the scope of the 40th Article so ; to comprise the former.

### 3. *Pseudo-cleavage.*

Some of the cleavages found in the Wesselton and ultfontein mines appear at first sight to be fragments of oken diamonds. Closer inspection, however, shows iat many have not the sort of freshly fractured surface at is got when a diamond is deliberately broken, but em to have undergone some natural process of growth id solution subsequent to their disruption. And many, ı said before, seem to have crystallised in a tight corner, here they had no chance to grow symmetrically. An kling of what may sometimes take place is given by a ultfontein diamond in my collection. This specimen is clouded brown macle of the orthodox spinel twin habit -a somewhat rare thing in the Kimberley mines (Note E) -measuring 6·7 mm. from corner to corner, and 5 mm. ick. To cursory inspection one of its triangular faces ems to be much cracked, but under moderate magnificaon the simulated cracks resolve themselves into deep itural grooves penetrating from a half to the whole way own to the seam (*i.e.*, from a quarter to half way through e stone), the sides of these natural grooves not probably ing in actual contact anywhere. On the face of the one the *sides* of the grooves are striated like the edges octahedra commonly are, or like the faces of rhombic odecahedra from Bultfontein. It really seems as though e stone must have grown outwards from the seam in *parate portions all at the same rate, keeping*, that is, *e overall dimensions to the correct spinel twin habit.* his diamond evidently could be broken up into distorted agments having pseudo-cleavage faces.

Sometimes two diamonds appear to have formed, one : either side of some foreign matter, the two together aking one stone of passable shape. An *interesting* though not exceptional case is that of a Koffyfontein diamond of about two carats, one half of the diamond being white and the other half yellow with a tinge of brown. A light tap on the diamond with a metal weight, and it fell into two parts along the plane dividing the two colours. Inside there were two tiny zircons and some apophyllite. This was certainly not a case in which the diamond had formed normally about the zircons and split afterwards, for the crystallisation had proceeded by two separate intentions. Precisely similar cases of crystallisation on either side of flakes of diamond are met with.

### 5. *Groups and Clusters.*

Sir H. A. Miers observes (*Ency. Brit.*, 1910) that "the majority of minerals are found most commonly in masses which can with difficulty be recognised as aggregates of crystalline grains, and occur comparatively seldom as distinct crystals; but the diamond is almost always found in single crystals, which show no signs of previous attachment to any matrix." The examination of many hundred specimens prompts me to suggest that his statement needs some modification. It may be granted that regular *octahedra and other tesseral forms were almost certainly* formed as single crystals; but the statistics given in "Kimberley Diamonds" show that these only make up a quarter of the whole production. Is it safe to dogmatise about the remaining three-quarters, even if there were no *direct evidence? As it happens there is a good deal of* direct evidence. Leaving out of account bort (which may be regarded as aggregates of crystalline grains), and interpenetrating crystals (found by the hundred at Bultfontein), and the terraced stones of Jagersfontein, groups and *clusters of diamonds are by no means uncommon. These* groups and clusters consist sometimes of diamonds of apparently perfect symmetry, sometimes of irregular lumps; and they may be all of one colour or there may be two or three different colours and textures. A brief description of one or two *will suffice*:—

1. A close cluster of separate diamonds, of which upwards of fifty can be counted on the outside. Originally it must have contained many more than it does now, for it is in so fragile a state that individual components are continually breaking away. Indeed, it is a wonder that it ever reached the sorting office as a cluster at all. The components are variously coloured from white to grey. Those that break off have fractured surfaces as well as surfaces of arrested growth.

2. A crystal diamond surrounded by a *cluster of bort.*

3. A branching group of five tiny dark grey diamonds, possibly coated stones. They seem to be rhombic dodecahedra, and are what is left of a larger group.

4. A beautiful group of three tiny white diamonds, two of which are well-shaped octahedra and one rounded.

5. An irregular group of ordinary grey bort of twenty or more components of irregular shape and of various shades of grey.

6. A Bultfontein cluster of yellowish diamonds of different habits. The principal member is a macle of 8·7 × 5·1 mm., one of whose seamed sides has developed into an octahedral face. Another side and one corner are distorted where a satellite diamond has broken away; while a well-shaped macle, of the same thickness but smaller and not lying quite in the same plane, has grown into the third side. Close to the second macle is a distorted octahedron, one of whose corners shows where there was once another diamond. Wedged between the second macle and the distorted octahedron are two dodecahedra—there seem to have been three originally.

*This list could be extended indefinitely*; and considering that the chances are against a group or cluster surviving intact the ordeal of mining and winning, it seems a fair inference that groups and clusters must be very common in the original matrix, and that it is immaterial to a diamond whether it forms individually or socially. In fact, saving lack of material, there is no reason why a

group of diamonds should not extend from one side of the mine to the other.

It might be argued against this view that possibly the components of a group have started from closely situated independent centres of crystallisation and coalesced by natural growth. Without going so far as to assert that such a thing had not happened and could not happen, it may yet be said that chances and appearances are against any such phenomenon. Moreover the case of the Bultfontein spinel twin macle described above, also the case following it of the Koffyfontein diamond, show in a way how separate diamonds can grow outwards independently from a common starting-place. Then there are occasional diamonds which seem to have set out by first intentions to be cubes, but have developed incipient octahedral forms at each corner, thus assuming a distant resemblance to the rare form in which the octagon and the cube combine symmetrically—the corners of the octahedron projecting through the centres of the cubic faces. Equally significant are the octahedra with re-*entering corners. Three of these have been preserved as* good specimens—rounded octahedra of different sizes and colours. It was not easy to interpret the indented corners, but it seemed reasonable to suppose that they must once have contained octahedron diamond satellites. Later on another such diamond was found with the corner satellites *in situ* and strongly held.

Now these cases do seem to indicate a group-forming tendency. The corner satellites surely must have formed after the primary diamond had reached an advanced stage. For it is not in reason that seven distinct centres of crystallisation should start so symmetrically placed that six outer ones should be exactly at the places of the final corners of the central one. Still less is it in reason that the same process should be repeated again and again.

I would submit that a theory of growth into groups and clusters after the manner of calcite and rock crystal affords an explanation of the habit of many "cleavages," whose irregular contours are not bounded by broken surfaces. It explains, may we say, why so many diamonds appear to have been formed in tight corners, and why so many have what look like surfaces of attachment. The so-called cleavages found *in situ* in the matrix are more often such misshapen diamonds from clusters than fractured fragments derived from single crystals. A flat white diamond in its blue-ground matrix, from De Beers Mine, is one of these misshapen stones. Its exposed length is 10 mm.; its thickness varies from 1 to 3 mm. It projects 5 mm. from the blue ground, while its outside edge *is broken off, accidentally or otherwise. It has all* the appearance of having once been in a cluster, and its exposed faces are much the same as that which prevails when two diamonds have crystallised together in easy contact.

Bultfontein Mine produces more groups and clusters than other mines do, perhaps for the same reason that it produces more interpenetrating crystals than all the other mines put together. Cross-grained stones in general, however, are not uniformly distributed throughout Bultfontein, so that, consequently, some market assortments contain great numbers, whereas others have much fewer. This same mine is pre eminently a source of rhombic dodecahedra, a good half of its symmetrical stones being of this habit; and the groups also seem to favour diamonds inclining to the same class.

### 6. *Rhombic Dodecahedra.*

*Bultfontein rhombic dodecahedra merge* on the one hand into occasional tetrahexahedra, white, yellow, and green, and on the other hand by imperceptible gradations through rounded octahedra to some glassies. Those of the midway class are of special interest. For purposes of description they may be regarded either as octahedra whose edges have disappeared in solution, or as dodecahedra whose corners have been truncated by octahedral faces. The octahedral faces are usually much indented with triangles, the dodecahedral and tetrahexahedral faces never. When these two are indented at all it is with small round pits. It is curious that it is only in this midway class of Bultfontein diamonds that triakis—and hexakis-octahedral afinities are seen, namely when the dodecahedral or tetrahexahedral edges invade the faces of the octahedron. The typical Wesselton octahedron, for example, shows no such affinities. (Note F). The prevailing striated surfaces and rounded forms of Bultfontein diamonds create refraction troubles which make it difficult sometimes to see whether the interiors are flawed or spotted.

### 7. *Twins.*

Interpenetrating twins are common enough at Bultfontein and relatively rare elsewhere. The two members of a twin combination are usually of the same habit, *i.e.*, they may be both octahedra, or both dodecahedra, or both macles. But there is no hard and fast rule, and any possible form may occur twinned to any other. As to their origin, Crookes suggests that "two drops, joining after incipient crystallisation, might assume the not uncommon form of interpenetrating twin crystals." Some of these twins certainly look as if they might have been formed in some such way—say two octahedra or two dodecahedra joined point to point by the slightest of bonds, or a macle joined to almost any isometric. Yet outside appearances on the whole point to consecutive rather than to concurrent growth. For there is unbroken gradation all the way from simple contact between two complete crystals down to absolute inclusion of one by another. It would be quite easy to arrange a collection of Bultfontein twins showing progressively one of a pair more and more deeply embedded in the other, *i.e.*, a point buried, a quarter buried, a half, three-quarters, and so on, then only a point sticking out, and lastly complete immersion.

It is not antecedently improbable, of course, that in each case the pair might have started together, and that one outgrew and in some cases finally, so to speak, over *flowed the other. But it is just as likely that one might* have started first, run its single course to the end, and then served as a nucleus for the other. And this view is supported by the venerable aspect of some inclusions.

Again, on the hypothesis of concurrent growth, how can we explain the twinning when one member has octahedral characteristics (? indicating growth) and the other dodecahedral characteristics (? indicating resorption) both members being nearly of a size.

The mutual orientation of twins does not appear to be governed by any law: the axes of one member may be set at any angle to those of the others. There is a likelihood however, that certain alignments may be favoured. Two macles, for example, interpenetrate by preference either nearly in the same plane though in opposite directions, or nearly at right angles, intermediate intersections being shunned. Even when the macles degenerate into bort they incline to the same rule. The McGregor Museum at Kimberley has a nice specimem of this interpenetrating macled bort.

Almost without exception there is great strain over the area where one of the twins cuts the other, whatever the depth of the union, due it may be to confused crystallisation about two sets of independent axes unsymmetrically co-ordinated.

### 8. *Hardness of the Diamond.*

Diamond is admittedly the hardest mineral in existence But there is a good deal of misconception about the purport of the fact. *Thus we are told (and can well believe* that there is a greater difference between the hardness of diamond (10) and that of corundum (9) than there is between the hardness of corundum and that of talc (1) and thence we are asked to infer that nothing else on earth will scratch diamond. Herbert Smith, for example says that Borneo diamonds "are remarkable for excessive hardness; they can only be cut with their own dust

ordinary diamond dust making no impression" ("Gem Stones," p. 154, 1912). Miers says that because of their hardness diamonds obtained from sands or gravels are rarely, if ever, water-worn ("Ency. Brit.", 11 Ed., 1910).

Now in order to be quite emphatic we will begin with the round assertion that there is nothing on earth that will *not* scratch a diamond. Drops of water wear away the stone. *Every mineral will scratch every other. It is only* a question of time and quantity of material. Given time enough a wheel of gypsum, if large en ugh, would grind a diamond to powder. The point of a glazier's diamond wears out in time; and so does carbonado used in a rock *drill. Some years ago a large diamond was used in the* De Beers workshops to take half an inch from the circumference of a corundum wheel fourteen inches in diameter. It did the work, but suffered grievous wear in the process.

Thus the water-worn aspect of innumerable diamonds obtained from gravels is no matter for wonderment. I have seen a Vaal River diamond worn as round and as rough as a marble, with scarce a trace of its original surface left. (Note G). More than that, a large yellow diamond belonging to the estate of the late Mr. B. Peiser a few years ago was scored with "criss-cross" glacial striæ. Hence the argument that a diamond could not have been used in the breastplate of the High Priest (Exodus xxviii. 18) because the Hebrews knew of no means of engraving a sign upon it loses some of its force. (Note H). Besides, it is only surmised and has not been proved that no lapidary of old had ever found out how to engrave a diamond. Arts are acquired and perish: *e.g. the way to cleave diamond was learned and forgotten* before Wollaston's time. (Note I).

*Notes.*

A. *Cf.* Sorby and Butler, "On the Structure of Rubies, Sapphires, Diamonds, &c.":—Brewster "thought that the black specks, which were surrounded by a black cross when examined with polarised light, were minute cavities; but at the same time he admitted that they were so small that it was not possible to say whether they contained a fluid or were empty. Judging from what we have seen of such small examples, we consider it impossible to say whether they are cavities or enclosed crystals."—*Proc. Roy. Soc.*, 1869.

B. Some artificial diamonds may be likened to Rupert's drops—perhaps because they have been cooled too quickly. Crookes, in his magnificent Kimberley lecture, mentioned one which burst and covered with fragments the slide upon which it was mounted.

C. *E.g.*: "It is notorious that the strain is occasionally so great that a diamond explodes into powder shortly after removal from its enveloping matrix of the blue clay."—A. E. H. Tutton, "Crystals," 1911, p. 207.

D. Sorby and Butler (*Proc. Roy. Soc.*, 1869) noticed that foreign inclusions exerted pressure on the surrounding diamond. And they say, "We, however, do not imagine *that the crystals [inclusions] have increased in size*, but that probably they have prevented the uniform contraction of the diamond, which must have been very irregular even when no such impediment was present." This suggestion ignores the *contraction of the inclusion. There is something* remarkably like hailstones in the structure of these specimens, and do doubt they have been formed like hailstones by alternate phases of crystallisation and accretion. Their characteristics must *have an important* bearing upon any rational theory of the genesis of the diamond. Could the old philosophers, who taught that precious stones were petrified ice, have seen such things they could have claimed a very decisive corroboration of their doctrine! "Other minerals, as fluor spar, apatite, idocrase, heavy spar, and calc-spar, disclose a similar structure by bands of different colours. A growth rendered intermittent through the deposition of a thin layer of foreign matter is thus developed."—A. F. Heddle, *Ency. Brit.*, 9th Ed., 1878, Art. "Mineralogy."

E. Most Kimberley macles have rounded edges witho re-entering corners.

F. The green octahedra from the Rand banket show su affinities to perfection.

G. (1) "The diamond, in spite of its great hardness, readily affected by attrition when transported over ev relatively short distances."—H. Merensky, "The Orig *of River Diamonds within the Area of the Vaal,*" *Tran Geol. Soc. S.A.*, 1907. (2) "The distinct wear seen many of the river diamonds suggested the same sour (the Dwyka) for many of those gems, as the attrition d to a slow-moving ground moraine, especially at or near *base, would be great enough to wear and triturate ev* the diamond."—H. S. Harger, "The Occurrence Diamonds in Dwyka Conglomerate, &c." *Ibid.*, 1909.

H. Apart from that a diamond in the breastplate mig have had a natural mark upon one of its faces whi simulated the signet sign of one of the tribes. Diamon occasionally carry remarkable intaglio outlines suggesti of the art of a runic scribe. On the other hand, t Septuagint (Lee Brenton's Version) does not use the wo diamond at all, but supplies some variant in every case.

I. Speaking of things that are hard Lucretius says that:

> "In quo iam genere in primis adamantina saxa
> Prima acie constant ictus contemnere sueta."

H. A. J. Munro gives "diamond stones" as the equivale of "adamantina saxa." *But cf.* "*Ovid*," *Fasti III.*—

> "Immolat hunc Briareus facta ex adamante securi,"

which certainly cannot be a diamond axe. F. A. Pal suggests basalt.—*Transactions of the Royal Society South Africa*, viii., Part 2.

## THE SPECTRUM OF ELECTRICALLY EXPLODE WIRES.

By J. A. ANDERSON.

High temperature absorption spectra, such as tho given by the sun and some stars, have not been reproduc fully in the laboratory. The absorption spectra obtain with the arc and the electric furnace have been limited wave-lengths below 0·56 $\mu$, and have not included t high-temperature lines. The author has developed method of obtaining high-temperature absorption spectr which consists in electrically exploding a fine wire in confined space. When the explosion occurs in air co fined in a tube or slot, the flash gives a brilliant continuo spectrum crossed by the absorption lines of the elemen composing the wire. The spectrograms reproduced sho that for iron an absorption spectrum was obtained wh extends to 0·66 $\mu$, and includes all classes of lin except the pronounced enhanced lines. Copper, nick and manganin were also investigated. When the meth has been more fully developed it may be possible imitate stellar absorption spectra of the solar type.

*New Laboratory Source of Light.*—By discharging large condenser, charged to 26,000 volts, through a fi wire 5 cm. long, about 30 calories of energy were dissipat *in about 10—5 sec. If all of this energy had gone in* the 2 mgrms. of wire it would have raised its temperatu to about 300,000°. Actually, the brilliant flash whi resulted had an intrinsic intensity corresponding to a te *perature of about 20,000°, or about one hundred times t* intrinsic brilliancy of the sun. The character of t spectrum and also the pressure developed depend, course, upon the energy per unit mass, and also upon t initial pressure and volume of the surrounding gas. Wh the wire was exploded within a tube or slot under a b jar exhausted to 2 cm. pressure, a line emission spectr was obtained. As the air pressure was raised the co tinuous background increased in intensity, and t spectrum became more and more an absorption spectru **Because of the high temperature, the continuous spectru**

extends far into the ultra-violet. This source should be useful in studying the pressure-shift of lines, as pressures of 50 atmospheres can readily be obtained. The spectrograms already secured show the effect clearly. The appearance of the flash is shown by direct photographs. Its size corresponds to a speed of propagation in open air of about 3·3 km. per second. Some striking mechanical effects of the explosion are briefly described.

*Meteorites falling into the Sun.*—In a theoretical discussion the author points out that meteorites falling into the sun would be given a relatively enormous amount of energy in a short time, and hence would be exploded by mechanical means, much as his wires were exploded by electrical means.

*Fine Wires.*—A simple method of producing on a lathe wires weighing down to 0·1 mgrm. per cm. was developed.—*Astrophysical Journal*, January, 1920.

## PROCEEDINGS OF SOCIETIES.

### ROYAL SOCIETY.

*Ordinary Meeting, June 10, 1920.*

Sir J. J. Thomson, O.M., President, in the Chair.

The following papers were read:—

"*The Thermo elastic Properties of Muscle.*" By A. V. Hill, F.R S, and W. Hartree.

The employment of a thermopile in a carefully closed-in chamber, immersed in well-stirred water inside a double-walled vacuum flask, together with photographic registering of the galvanometer response, has made it possible to record the thermal consequences of stretching a muscle (or a piece of indiarubber), or of releasing a muscle already stretched. When a muscle, alive or dead, is *stretched*, heat is liberated in relatively large amount at first, but at a rapidly diminishing rate. When a stretched muscle is *released*, there is at first a rapid absorption of heat followed by a more prolonged evolution of heat. In a complete cycle of lengthening and shortening, the net result is a production of heat, which is greater the longer be the interval between the two processes. These thermo-elastic effects are large enough to afford a notable complication in the measurement of the heat-production of a live muscle excited to contract. Their explanation is as follows:—

(*a*) The muscle, like a fiddle-string, shortens on being warmed; conversely, according to the second law, it will warm on being stretched and cool on being released. This explains the initial effects.

(*b*) The muscle, like other colloidal jellies, takes some time to reach an equilibrium length on being stressed; consequently, on stretching it *more* work is done, and on releasing it *less* work is obtained than is accounted for by the elastic potential energy existing in it when it has reached its full equilibrium length. The balance in either case appears as an irreversible production of heat. This accounts for the secondary effects.

The phenomena appear to be of physical as well as of physiological interest.

"*The Absorption of Light by Elements in the State of Vapour: Selenium and Tellurium.*" By Sir James Dobbie, F.R S., and J. J. Fox.

In a previous communication (*Proc.*, A, 1919, xcv., 484) it was shown that the absorption of light by sulphur vapour reaches a maximum at a temperature of about 650° C., and that at this temperature the vapour density corresponds with the average molecular weight $S_3$. Selenium and tellurium behave much in the same way as sulphur—the absorption increasing up to a certain temperature, above which it again diminishes. In the case of selenium the maximum absorption occurs between 650° C. and 700° C., and vapour density determinations show that the average molecular weight at this point corresponds to $Se_3$. With tellurium the maximum absorption is found to occur about 1200° C. The vapour of this element consists of diatomic molecules at 1800° C., but nothing is known of its constitution at lower temperatures. Its general similarity, however, to sulphur and selenium as regards absorption of light, renders it highly probable that at 1200° C. and below this temperature the vapour is much more complex than at 1800° C. The absorption spectra of selenium and tellurium are marked by the presence of large numbers of sharp narrow bands, and that of tellurium shows a wide absorption band of which the centre is approximately at $\lambda$3800.

"*The Absorption of Light by Elements in the State of Vapour: Mercury, Cadmium, Zinc, Phosphorus, Arsenic, Antimony.*" By Sir James Dobbie, F.R.S., and J. J. Fox.

These elements, unlike those of the sulphur group, do not show channelled absorption spectra when the Nernst filament is used as the source of light. Mercury, cadmium, and zinc, which are monatomic, transmit practically the whole of the light at all temperatures. Cadmium, however, shows a few narrow absorption bands, of which one at $\lambda$3261 is the most striking. In the cases of the tetratomic elements, phosphorus, arsenic, and antimony, general absorption occurs and increases regularly with rise of temperature up to 1400° C. There is no indication of a maximum followed by a diminution of absorption.

The peculiar absorption phenomena of the elements of the sulphur group are in all probability due to the breaking down of complex into simpler molecules; *e.g.*, $S_8$ into $S_2$, with the formation of molecules of intermediate complexity. With monatomic molecules no such dissociation can occur. With the tetratomic elements there is undoubted dissociation; but the changes are much less complicated than in the case of sulphur, the tetratomic simply splitting up into diatomic molecules. It is, however, to be noted that the highest temperature at which silica tubes can be used is 1400° C. It is possible that at still higher temperatures further dissociation of the tetratomic elements would result, accompanied by absorption phenomena similar to those observed in the case of sulphur.

"*Monoclinic Double Selenates of the Copper Group.*" By A. E. H. Tutton, F.R.S.

This memoir deals with the four double selenates of the series $R_2M(SeO_4)_2.6H_2O$, in which M is copper and R is potassium, rubidium, cæsium, and ammonium. A complete crystallographic and physical investigation has been carried out, similar to the work previously published concerning the magnesium, zinc, iron, nickel, and cobalt groups, and to that on the analogous double sulphates. The results confirm the conclusions derived from all the groups previously studied, and in a peculiarly valuable manner; for the copper-containing group affords crystals with morphological angles and elements, and physical constants, which differ appreciably in their absolute values from those afforded by the other groups—in this respect resembling the double sulphates containing copper. Yet the relationships between the values for the four salts are precisely the same, leading thus to exactly the same general conclusions as in the cases of those other groups. Every group exhibits its own idiosyncrasies, and the copper groups do so in a specially notable manner. Yet the same progression according to the atomic weight and atomic number of the alkali metal present is exhibited in the case of every property, whether morphological, such as the crystal angles and the topic axial ratios, or physical, such as the double refraction and the molecular refraction; also the ammonium salt salt proves to be practically iso-

structural with the rubidium salt. The most recent work on the structure of the atom, and the further elaboration of Moseley's law connecting the atomic number with the atomic structure and complexity, has only strengthened the conclusion that the author's results are a natural consequence of the operation of Moseley's law—the progression in the crystal properties following the progression in the complexity of the alkali-metallic atoms, which exert so dominating an influence in determining the structure and properties of these crystals.

"*Production and Transmission of an Environmental Effect in* Simocephalus vetulus." By H. G. CANNON.

The experiments were undertaken in order to repeat, if possible, Agar's work on the production and transmission of an abnormality in *Simocephalus vetulus*. The magnitude of the abnormality, which consisted in a change in the curvature of the valves of the carapace, could be measured by the Length/Width ratio L/W. The results indicate that the abnormality can be produced by feeding a culture containing practically no other Protozoon than Chlamydomonas.

The L/W ratio was found to be too variable to allow of its measurement with sufficient accuracy on which to base considerations as to the existence or non-existence of a "reaction" to the abnormality of such a magnitude as that indicated by Agar. The experiments showed that no antibody was produced to eliminate the cause of the abnormality.

"*The Enzymes of* B. coli communis, *which are concerned in the Decomposition of Glucose and Mannitol.* Part 4. *The Fermentation of Glucose in the Presence of Formic Acid.*" By E. C. GREY (John Foulerton Student).

By carrying out the fermentation of glucose by bacteria in the presence of calcium formate, the writer has been able to upset the normal balance which exists between certain of the products, and thus to show that they are in reality formed by separate enzyme actions. Hitherto an approximately constant relationship has been found between the formic acid and carbon dioxide on the one hand and the alcohol and acetic acid on the other. This relationship is shown to be rather accidental than essential. It results probably from the fact that the hydrogen which arises from the decomposition of formic acid co-operates in the formation of alcohol, and thus the two reactions of alcohol formation and carbon dioxide formation tend to keep pace with one another. The addition of more formic acid at the outset of the fermentation tends, however, to prevent the production of formic acid from glucose, and to destroy the ratio which normally exists between this formic acid and the alcohol and acetic acid, thus proving that these products arise by at least two separate enzyme actions.

Taken in conjunction with the writer's previous finding, that lactic acid is formed from glucose by *Bacterium coli* by a mechanism which is independent of that which gives rise to the other products, it is clear there that glucose may break down under the influence of these bacterial enzymes in three independent ways, giving rise to the following three groups of products:

1. Formic acid, carbon dioxide, and hydrogen.
2. Alcohol, acetic acid, and succinic acid.
3. Lactic acid.

These groups apparently represent three separate lines of cleavage of the glucose molecule under the influence of the enzymes of the bacterium in question. The writer is of opinion that this manner of cleavage is fundamental.

The experiments also show that alcohol is produced, in part, at least, by reduction, and prove, for the first time, that such reduction does actually occur by the action of hydrogen liberated from the glucose, as well as that, under certain circumstances, the hydrogen derived from the added calcium formate exerts a reducing action and increases the yield of alcohol.

"*Studies on Synapsis. II. Parallel Conjugation and the Prophase Complex in Periplaneta, with Special Reference to the Premeiotic Telophase.*" By L. T. HOGBEN.

Synapsis in the Orthoptera has been the subject of considerable controversy. The earliest events of synapsis in the ovaries of the cockroach are traceable with much greater facility than in the testes. They involve in either case the parallel conjugation in pairs of the full diploid number of leptotene loops. Morse's account of the origin of the heterotype rings by separation of the diplotene threads along the line of cleavage is confirmed and amplified by a segmental analysis of the metaphase complex. It is seen that two chromosomes at this stage (*d* and *a*¹) retain the looped condition of the post-synaptic bouquet till the others have divided—a fact which led earlier workers to interpret the genesis of the heterotype annular chromosomes according to the telosynaptic hypothesis. The accessories are not distinguishable in oogenesis from the autosomes. The vacuolation of the plasmosome during yolk formation in the oocyte is described in detail, and a re-examination of material for a previous paper indicates that the so-called "chromatin" granules described by so many writers, as emitted during yolk formation in the insect egg, are in reality products of the plasmosome. There is no evidence that in Periplaneta the plasmosome is related in any way to the chromatin organisation of the nucleus.

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## GEOLOGICAL SOCIETY.

*June 9, 1920.*

Mr. R. D. OLDHAM, F.R.S., President, in the Chair.

THE President said that, during the war, when the ordinary supply of papers for reading and discussion fell short, a series of lectures by workers on subjects cognate with geology had been instituted to fill the gap. These had been so well received and appreciated that it was hoped to continue the practice, and to devote, at any rate, one meeting in each session to this purpose. The subject of that afternoon's lecture came so far within the scope of the objects for which the Society was established that it threw considerable light, at any rate, on the structure of the Earth. Dr. Knott had worked out a method of mathematical discussion of the long-distance records of earthquakes by which it was possible to calculate the form of the wave-paths along which the disturbance had been propagated, without recourse to the approximations and assumptions previously needed, and from these calculations it was possible to deduce conclusions of great interest regarding the constitution and structure of the Earth.

Mr. CARGILL GILSTON KNOTT, D.Sc., LL.D., F.R.S., then proceeded to deliver a Lecture on "*Earthquake Waves and the Elasticity of the Earth.*" The Lecturer remarked that the record produced on delicate seismographs of the earth-movements due to distant earthquakes proves that an earthquake is the source of two types of wave-motion which pass through the body of the Earth, and a third type which passes round the surface of the Earth. Before earthquake records were obtained, mathematicians had shown that these three types of wave-motion existed in and over a sphere consisting of elastic solid material. Many volcanic phenomena, however, suggest the quite different conception of a molten interior underlying the solid crust. At first statement these views seem to be antagonistic; but there is no difficulty in reconciling them. Whatever be the nature of the material lying immediately below the accessible crust, it must become at a certain depth a highly-heated fairly homogeneous substance behaving like an elastic solid, with two kinds of elasticity giving rise to what are called the compressional and distortional waves. The velocities of these waves are

markedly different, being at every depth nearly in the ratio of 1·8 to 1. Both increase steadily within the first thousand miles of descent towards the Earth's centre, the compressional wave-velocity ranging from 4·5 miles per second at the surface to 8 miles per second at depths of 1000 miles or more; the corresponding velocities of the distortional wave are 2·5 and 4·3 at the surface and at the 1000 mile depth respectively. At greater depths these high velocities seem to fall off slightly; but the records fail to give us clear information as to velocities at depths greater than about 2500 miles. Down to this depth the Earth behaves towards these waves as a highly-elastic solid. The elastic constants, which at first increase with depth more rapidly than the density, become proportional to the density, for the velocity of propagation becomes practically steady. About half-way down, however, the material seems to lose its rigidity (in the elastic sense of the term), and viscosity possibly takes its place, so that the distortional wave is killed out. In other words, there is a nucleus of about 1600 miles radius which cannot transmit distortional waves. This nucleus is enclosed by a shell of highly-elastic material transmitting both compressional and distortional waves exactly like an elastic solid.

In conveying to the Lecturer the thanks of the Meeting for his illuminating discourse, the PRESIDENT said that, although these lectures were not open for discussion as in the case of an ordinary paper, he might be permitted to express a personal feeling of gratification that his own pioneer efforts in the same line had been confirmed by the Lecturer's fuller discussion, not merely in kind, but to an unexpected degree as concerned numerical estimates. The most important result of the investigations which had been described appeared to be the discovery of the remarkable reversal in curvature of the wave-paths at a depth of about 1000 miles. It might be a mere coincidence that this was also the depth of separation, according to one well-known hypothesis, between the metallic nucleus and the stony shell of the Earth, but the coincidence was at least suggestive, and the discovery was entirely due to the Lecturer, having been unknown before it was brought out by the ingenious and exact methods of discussion which had been elaborated by him.

## MINERALOGICAL SOCIETY.

*Ordinary Meeting, June 15, 1920.*

Dr. A. E. H. TUTTON, F.R.S., Past-President, in the Chair.

"*Rare Zinc-copper Minerals from the Rhodesian Broken Hill Mine, Northern Rhodesia.*" By F. P. MENNELL.

Copper minerals, including malachite, chessylite, copper-glance, and undetermined phosphates, are of rare occurrence in the lead zinc ore of this locality. Still rarer are the copper-zinc minerals aurichalcite and veszelyite; the latter forms minute sky-blue monoclinic crystals ($a:b:c = 0·971:1:0·95$), and differs from the original mineral from Hungary in its colour and in containing little or no arsenic.

"*Note on the Plumbiferous Barytes from Shibukamo, Prefecture of Akita, Japan.*" By Prof. R. OHASHI.

This mineral, which is deposited as a white to brownish yellow crystalline crust in the fissures and near the orifices of hot springs, is similar to the mineral recently called "hokutolite" from Taiwan (= Formosa); it contains 4·60 to 17·78 per cent of PbO, and is radio-active.

"*The Fibrous Gypsum of Nottinghamshire.*" By W. A. RICHARDSON.

The relation to the nodular types of gypsum of the fibrous veins of the mineral which are associated with every other type of gypsum deposit in the district, and occur at levels where there is no other development of the mineral, was considered. Most of these veins are regarded as having been formed shortly after the nodular deposits. The fibres grew upwards and downwards from a plane in the marl, and were probably deposited by descending solutions, being precipitated at planes of tension in a contracting medium. The veins of fibrous calcium carbonate of "beef" described by Dr. Lang show similar structure and field relations, and doubtless originated under similar conditions.

"*A New Model Rotating-stage Petrological Microscope.*" By W. A. RICHARDSON.

This instrument is intended as a substitute for the larger pre-war models, which at the present time could only be manufactured at very high prices. It is provided with a mechanical stage interchangeable with a plane stage and a conventional sub stage, and provision is made for rapid change from parallel to convergent polarised light. Owing to the reduction in size a rotation of 270° only can be provided for the rotating stage.

"*Models Illustrating the Atomic Arrangement in Potassium Chloride, Ammonium Chloride, and Tartaric Acid.*" By W. BARLOW.

In the case of the chlorides the suggested structure reconciles the X-ray phenomena with the crystalline symmetry. The arrangement proposed for tartaric acid agrees with the graphical formula of the chemists, and the molecular groups have the symmetry and relative dimensions of the crystals.

# CORRESPONDENCE.

## MINING ROYALTIES.

*To the Editor of the Chemical News.*

SIR,—In regard to the controversy now raging concerning mining royalties, it seems to me that in Lord Gainford's Mining Bill, now before the Commons—particularly as it affects the position of royalty-owners—we English people have once more a splendid opportunity of displaying our talent for compromise.

No one, I think, would have the temerity to suggest that more than a very small percentage of royalty-owners have in the past displayed that unselfishness and public spirit so highly desirable in any trade or calling which vitally affects the community. But the highly-expensive policy now proposed by the Government, of removing the private royalty owners altogether, and themselves collecting the royalties, seems to me a most unnecessary one, the more so as we have, embodied in Lord Gainford's Bill, the admirable suggestion of establishing an authority before which any royalty-owner suspected of hindering the best interests of the country could be arraigned, and, if found guilty, summarily dealt with.

The royalty-owner would thus remain with us, thereby meeting the views of those who feel that it is better, where possible, to build the future on the foundations of the past, and the views of those who quite rightly object to one small body of people having complete power over what will, for at least centuries to come, be the most vital key industry of civilisation.—I am, &c.,

ECONOMIST.

## NEW CADMIUM-VAPOUR ARC LAMP.

*To the Editor of the Chemical News,*

SIR,—In your issue of June 11 there is an article by F. Bates which was originally published in the *Philosophical Magazine* on a new cadmium vapour arc lamp, in which a similar lamp described by me is subjected to adverse criticism. As I have already replied to Mr. Bates's criticism in the current issue of the *Phil. Mag.*, p. 678, perhaps it will be sufficient if you will kindly allow me to

point out here that the statement made that "the impurities introduced into the lamp" by my method of filling "effectively prevent obtaining a relatively pure intense cadmium spectrum" must obviously be based upon faulty manipulation, since the only impurity I recommend introducing is zirconia, and pure zirconia does not affect the cadmium spectrum. In reply to Mr. Bates's statement that the lamps invariably crack after very short use, I obtained evidence from two independent users of my lamps, one of whom states that he has had one of my lamps in continuous use since September 6, 1916, during which time it has often burnt two or three hours on end. The other writes that his lamp has been heated up at least 500 times and has burnt for over 600 hours. Mr. Bates's unfortunate experience in this direction must therefore also have been due to faulty workmanship.—I am, &c.,

Henry J. S. Sand.

The Sir John Cass Technical Institute,
Jewry Street, Aldgate, E.C. 3.
June 18, 1920.

## NOTES.

Messrs. B. Laporte, Ltd., of Luton and Bradford, intimate that the large Formic Acid plant which has been in course of erection at their Bradford Works for the last two years is now completed. The acid produced is of 80 per cent strength, water white, and is considerably more economical to use than acetic acid at present market prices of the two acids.

Gas-masks for Ammonia.—Messrs. Perrott, Yablick, and Fieldner, of the Chemical Warfare Service (*Journ. Ind. Eng. Chem.*, 1919, vol. xi. 1015), describe a new form of gas-mask, especially adapted to the protection of workmen in industries in which refrigerating plants are operated. They point out that the usual method which employs pumice drenched with sulphuric acid has several objectionable features, among which are production of much heat by the absorption, high initial resistance, and the necessity for a canister capable of resisting corrosion. Caustic fumes are also produced which must be stopped by a pad, thus increasing the difficulty of breathing. They experimented with salts having the property of combining with ammonia, and give preference to pumice stone saturated with copper sulphate. This was shown to have a great capacity of absorption. A canister containing 45 cubic inches of this material will protect a man, breathing at rest, for five hours against an atmosphere containing 2 per cent of ammonia and for two and one-half hours in an atmosphere containing 5 per cent. Tests at high breathing show that protection is ample at great exertion. Several other substances are efficacious, among which are cobalt chloride, boric and silicic acids. The copper sulphate method has the advantage of large capacity of absorption, low heat disengagement and cheapness. In this connection, note should be made of a statement from the British Home Office (For. Ind. News, *Journ. Ind. Eng. Chem.* 1919, xi., 1064) that the ordinary army masks do not serve as protection in dealing with mine fires, or entering the mine after explosions. The atmosphere in such cases contains a good deal of carbon monoxide, against which the ordinary charges of the mask are inert, and further, there is often a decided diminution of the proportion of oxygen, which may in itself be a great danger. Inasmuch as the masks protect against smoke, they give a feeling of security to a person entering the smoky air and thus add to the likelihood of his being overcome.—*Journ. Franklin Institute.*

Science and Industry.—The Iron Founding Industry, through the Institution of British Foundrymen, have decided to form a Research Association. It is intended primarily for the grey and malleable cast-iron trades, and the scheme will be under the auspices of the Government Department of Scientific and Industrial Research, which has a million pounds for furthering such work. It is proposed to have the offices and laboratories and bureau of information in Birmingham, and Mr. T. Vickers has been appointed technical adviser. He is Secretary of the Birmingham Metallurgical Society. Iron founding is greatly in need of the aid of science, and hitherto it has not drawn a good class of labour. There are 2800 foundries in Great Britain, 285 being in Scotland and 50 in Ireland. In the Midland area there are 828 and Birmingham has the most foundries of any town—118. Yorkshire has the largest number of any county—415.

Sir John Cadman, Professor of Mining in the University of Birmingham, has resigned his position in order to become technical adviser to the Government on questions affecting petroleum and oil. Upon these he has frequently been called into consultation by the Government since the Armistice, and he was often in attendance at the Peace Conference in Paris and also at San Remo. He came into prominence last year in connection with the discovery of oil in Derbyshire. Sir John, who is forty-three years of age, a native of Newcastle (Staffs.), and was knighted 1918, some years ago made a special research on mining matters for the Royal Commission, and he has been a member of a Royal Commission reporting on the oil fields of Persia, Director of the Petroleum Executive, and Chairman of the Inter Allied Petroleum Conference. At the Birmingham University he succeeded Sir R. Redmayne, the Chief Inspector of Mines. The Senate has now created a new position—that of Assistant Professor of Petroleum Technology.

The Secretary of the Department of Scientific and Industrial Research begs to announce that the Research Association for the British Motor Cycle and Cycle Car Industry has been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit sharing company, the promoters have applied to the Board of Trade for the issue of a license under Section 20 of the Companies' (Consolidation) Act of 1908. The Secretary of the Committee engaged in the establishment of this association is Major H. R. Watling, "The Towers," Warwick Road, Coventry.

Sea-weed for Paper Making.—As a result of the paragraph which appeared in the *Board of Trade Journal* of May 20, the Thames Paper Company, Limited, has carried out an experiment on the sea-weed that is to be found in the estuary of the Thames, and which is a fairly common type along the shores of this country. This was dealt with in the Company's laboratory, and the chemist's report is given below; from this it will be observed that the fibre contents of this sea-weed is practically nil. It is probable, however, that the type of sea weed suitable for this purpose is somewhat different, for, as stated in various issues of the *Journal*, viz., p. 837 January March, 1917; p. 678, July December, 1919; p. 238, February 12 1920, companies have been formed in Italy and Japan for the purpose of exploiting sea-weed in this way. In 1917, the South Australian Department of Chemistry published a Bulletin on the subject. As the possibility of utilising this raw material in the manufacture of paper is of great interest at the present time, further enquiries are being made into the question. The chemist's report referred to above is as follows:—Samples from the local foreshore have been carefully examined from the above standpoint:—Water content, 73.50 per cent (as received); Bone dry weight, 26.50 per cent. This latter was chiefly dirt and foreign matter, salt (sodium chloride and other halogens), and colloidal substances akin to gelatin. The amount of fibre was practically negligible and was extremely difficult to isolate on account of the "Colloids." Cellulose was not worth estimation, and the sample was useless as a raw material for paper making.

AUSTRIAN MAGNESITE DEPOSIT.—The following communique from the Veitscher Magnesite-Werke, A.G. to the Vienna newspapers of May 6th, is reported to the Department of Overseas Trade by the British Commercial Commissioner:—"The Union Bank (of Vienna) has ceded a part of its Veitscher shares to a syndicate which is intended to last for a considerable time and is composed of the Union Bank itself, the great firm of Schneider and Co. in Paris, and the company Karl Spaeter in Basle. The maintenance of the purely Austrian character of the Veitscher Magnesite Werke Company and the control that has hitherto been exercised by the Union Bank is secured. The Veitscher Magnesite Company has the largest deposits of this mineral in Austria, and exports much to America. The shares, nominally 400 Kronen, are now quoted about 15,000 Kronen."

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